UC Berkeley Archaeobotany Laboratory Report #86: Compilation of Phytolith and Starch Images of Taxa Relevant to the Contemporary Caribbean
Natasha A. Fernández-Pérez and Christine A. Hastorf
Fall 2018
Date: September 12, 2018

Background:

In Spring 2018, Natasha A. Fernández-Pérez approached Christine A. Hastorf because she wanted to do a Directed Reading on phytolith and starch applications to archaeology. Since she wanted to work on the Historical/Contemporary Caribbean, where the plantscape has been affected by colonialism, imperialism and globalization, the readings ranged from all over the Neotropics and included few relevant plants from the Old World (e.g., rice, bananas and Near Eastern cereals). To organize the information and morphotypes presented in these readings by plant taxa, and following professor Hastorf’s advice, she created a file where the images were arranged in alphabetical order by family, genus and species, with their respective references. In total, 81 families were included:

<table>
<thead>
<tr>
<th>Acanthaceae</th>
<th>Cucurbitaceae</th>
<th>Menispermaceae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acharantheraceae</td>
<td>Cyatheaceae</td>
<td>Moraceae</td>
</tr>
<tr>
<td>Anacardiaceae</td>
<td>Cyperaceae</td>
<td>Musaceae</td>
</tr>
<tr>
<td>Annonaceae</td>
<td>Dasygononaceae</td>
<td>Myristicaceae</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>Dichapetalaceae</td>
<td>Myrtaceae</td>
</tr>
<tr>
<td>Araceae</td>
<td>Dilleniacae</td>
<td>Orchidaceae</td>
</tr>
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<td>Arecaaceae</td>
<td>Dioscoreaceae</td>
<td>Oxalidaceae</td>
</tr>
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<td>Asteraceae</td>
<td>Ebenaceae</td>
<td>Piperaceae</td>
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<td>Barringtoniaceae</td>
<td>Elaeocarpaeae</td>
<td>Poaceae</td>
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<td>Basellaceae</td>
<td>Ericaceae</td>
<td>Pteridaceae</td>
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<tr>
<td>Bataceae</td>
<td>Erithroxelaceae</td>
<td>Restionaceae</td>
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<tr>
<td>Bignoniaceae</td>
<td>Euphorbiaceae</td>
<td>Simaroubaceae</td>
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<td>Fabaceae</td>
<td>Smilaceae</td>
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<td>Bombacaceae</td>
<td>Fagaceae</td>
<td>Solanaceae</td>
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<td>Boraginaceae</td>
<td>Flacourtiaceae</td>
<td>Sterculiaceae</td>
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<tr>
<td>Brascaceae</td>
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<td>Strelitziaceae</td>
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<td>Bromeliaceae</td>
<td>Heliconiaceae</td>
<td>Thelypteridaceae</td>
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<td>Burmanniaceae</td>
<td>Hernandiaceae</td>
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<td>Burseraceae</td>
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<td>Hymenophyllaceae</td>
<td>Ulmaceae</td>
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<td>Cannabaceae</td>
<td>Juglandaceae</td>
<td>Urticaceae</td>
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<td>Cannaceae</td>
<td>Juncaceae</td>
<td>Zamiaceae</td>
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<td>Chloranthaceae</td>
<td>Lauraceae</td>
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<td>Chrysobalanaceae</td>
<td>Loranthaceae</td>
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<td>Clusiaceae</td>
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<td>Combretaceae</td>
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<td>Commelinaceae</td>
<td>Magnoliaceae</td>
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<td>Convulvulaceae</td>
<td>Malvaceae</td>
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<tr>
<td>Costaceae</td>
<td>Marantaceae</td>
<td></td>
</tr>
</tbody>
</table>
References Included:
McCown Archaeobotany Laboratory Collections:
- Australian Museum
- Korstanje and Babot


ACANTHACEAE
2. Segmented hairs from Justicia pringlei with tapered shafts and small, rounded apexes. The hair on the left is broken near the base (156 x ).

3. Right, a cystolith from Justicia pringlei showing the tuberculate surface decoration. On the left is a completely silicified segmented hair attached to a hair base (156 x ).

Mendoncia spp.

Phytolith

Fig. 5. Genus-specific phytolith from the seeds of Mendoncia spp. recovered from modern soils underneath tropical montane forest in Panama.

Mendoncia coccinea

Phytolith

4. Non-segmented club-shaped hairs from Mendoncia coccinea (156 x).

Odontonema bracteolata

Phytolith

1. An elongate cystolith from Odontonema bracteolata. The tuberculate surface pattern is developed only on the right end of the cystolith (156 x)

Pseuderanthemum davei

Phytolith

2. Cystoliths from Pseuderanthemum davei (250x).

AMARANTHACEAE
## Amaranthus caudatus

### Amaranthaceae  *Amaranthus caudatus* "amaranto, coimi or quiwicha"

#### Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>Type</th>
<th>Features</th>
<th>References</th>
</tr>
</thead>
</table>
| **Flower and Seed** | Non diagnostic phytoliths (*•*):
  a) Flat round scrobiculate margin silica phytolith. Rare.
  b) Asymmetrical bilobate (saddle) silica short cell. Rare.
  c) Conical scrobiculate silica phytolith. Rare.
  d) Asymmetrical silica phytolith. Rare. | Reported as not present in Piperno 1988:30 for *Amaranthus* sp. |

| Stem | Non diagnostic phytoliths (*•*):
  a) Sub-spherical globose silica phytolith. Rare. | Reported as not present in Piperno 1988:30 for *Amaranthus* sp. |

| Leaf | Non diagnostic phytoliths (*•*):
  a) Spherical globose silica phytolith. Rare. | Reported as not present in Piperno 1988:30 for *Amaranthus* sp. |

#### Starch assemblage characterization

<table>
<thead>
<tr>
<th>Type</th>
<th>Features</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flower and Seed</strong></td>
<td>a) Mainly semi-compound grains called &quot;starch chunks&quot;, compounded by single grains compactly disposed and filling the whole cell. Granules spherical and polyhedral, ranging in size from 1.5μm to 5μm long length, not visible hilum and lamella, distinct cross.</td>
<td>Partially based on Belto Perez et al. 1998; Cortella and Pochettino 1990 and 1994; Wilhelm et al. 1998.</td>
</tr>
</tbody>
</table>

| Flower and Seed | b) Also, single grains, spherical and bell-shaped with facets; variable in size from 11μm to 75μm; visible hilum as a dot; not visible lamella, distinct centripetally cross, with four arms visible. May occur in aggregates. | |

Scale bar = 20μm.
**Amaranthus mantegazzianus**

Amaranthaceae  *Amaranthus mantegazzianus* "amaranto, chaclion or chaquillon"

### Phytolith assemblage characterization

### Starch assemblage characterization

**a)** Mainly semi-compound grains called "starch chunks", compounded by single grains compactly disposed and filling the whole cell. Single grains, spherical or polyhedral; ranging in size from 0.5μm to 3μm long length; not visible hilum and lamella; sometimes indistinct cross.

**b)** Another compound grains, fiber-like, with a single external package; variable in size and number of granula. Granula; uncertain shaped; distinct centric hilum as a dot; distinct centric cross, with four arms visible.

**c)** Also, single grains, polyhedral, spherical, irregular and bell-shaped, with facets; variable in size from 5μm to 75μm long length; visible hilum as a dot; not visible lamella; distinct centric cross, with four arms visible. May occur in aggregates.

**References:** Partially based on Cortella and Pochettino 1990 and 1994.

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**Scale bar = 20μm.**

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**Korstanje and Babot, McCown Archaeobotany Laboratory Collection**
Amaranthus mantegazzianus

Starch

Chenopodium quinoa

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Chenopodium quinoa

Chenopodium quinoa

Figure 12. Starch of quinoa flour showing milling effects. (a) Compounded grains in different stages of disjoining and a disjoined individual grain are marked with arrows. View with normal light (left). (b) View with polarised light (right). Scale bar = 20µm.

ANACARDIACEAE
Spondias purpurea

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: fruit/seed

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
ANNONACEAE
Annona glabra

Phytolith

Duguetia sp.

Phytolith

Facets and overall shape both irregular, often with concave surfaces. NOT a regular, symmetrical sphere. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Goniothalamus marcani

Phytolith

Fig. 3. (a) Facetate phytoliths from Asian Fagaceae (Lithocarpus acuminatissima), left, and Annonaceae (Goniothalamus marcani), right. Reprinted from Kealhofer and Piperno, 1998. Reprinted from Piperno (2006a), Copyright AltaMira Press.

Guatteria dumetorum

Fig. 3. (b) Spherical facetate, right (Unonopsis pittieri), and irregular facetate phytoliths, left (Guatteria dumetorum) from tropical American Annonaceae. Reprinted from Piperno (2006a), Copyright AltaMira Press.

Guatteria guianensis

Phytolith

Fig. 5. Phytoliths from dicotyledons. 
b) Irregular multi-faceted phytolith from Guatteria guianensis leaf

Unonopsis pittieri

Fig. 3. (b) Spherical facetate, right (Unonopsis pittieri), and irregular facetate phytoliths, left (Guatteria dumetorum) from tropical American Annonaceae. Reprinted from Piperno (2006a), Copyright AltaMira Press.

Unonopsis stipitata

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. j) Tracheid from Unonopsis stipitata

Unonpsis stipitata

Phytolith

Fig. 5. Phytoliths from dicotyledons.
a) Spherical multi-faceted phytolith from Unonpsis stipitata

APIACEAE
Arracacia xanthorrhiza

Korstanje and Babot, McCown Archaeobotany Laboratory Collection

<table>
<thead>
<tr>
<th>Apiaceae Arracacia xanthorrhiza “arracacha”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytolith assemblage characterization</td>
</tr>
<tr>
<td>tuber</td>
</tr>
<tr>
<td><strong>References:</strong> Reported as a family where phytoliths have been found to be not present, rare or not taxonomically significant in Pearsall 2000:371.</td>
</tr>
</tbody>
</table>

Scale bar = 20μm.
ARACEAE
Alocasia sp.

Australian Museum, McCown Archaeobotany Laboratory Collection
Amorphophallus companulatus

Araceae
Amorphophallus campanulatus

corm
No. 276 x500

Araceae
Amorphophallus campanulatus
corm
No. 276 x1000

Australian Museum,
McCown Archaeobotany Laboratory Collection
Colocasia affinis

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Colocasia esculenta

Araceae
Colocasia esculenta
corm
No. 254
x1000

Araceae
Colocasia esculenta
corm
No. 254
x1000

Araceae
Colocasia esculenta
corm
No. 255
x1000

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Colocasia esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Colocasia esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Colocasia esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Colocasia esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Colocasia esculenta

Araceae
Colocasia esculenta
com
No.252
x1000

Araceae
Colocasia esculenta
com
No.267
x1000

Araceae
Colocasia esculenta
com
No.267
x1000

Australian Museum, McCown Archaeobotany Laboratory Collection
Colocasia esculenta

Australian Museum,
McCown Archaeobotany Laboratory Collection
Colocasia esculenta

Phytolith

Type established by Karol Chandler-Ezell, 2004. Cultivated tuber. Diagnostic level: undetermined

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Colocasia fallax

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Colocasia gigantea

Araceae
Colocasia gigantea
corn
No. 285
x1000

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Cyrtosperma chamissonis

Australian Museum, McCown Archaeobotany Laboratory Collection
Cyrtosperma chamissonis

Australian Museum, McCown Archaeobotany Laboratory Collection
Xanthosoma sagittifolium
Xanthosoma sagittifolium

APPENDIX:
Xanthosoma sagittifolium (yautia, malanga). Compound grains, not laminated often without a fissure. Very defined pressure facets with conspicuous edges. Size: 2–16 microns long

Xanthosoma sagittifolium

Xanthosoma undipes

Starch

Xanthosoma violaceum

Starch

Xanthosoma sp.

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: not determined

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
ARECACEAE
Arecaceae

Phytolith

a. Globular echinate diagnostic of the Arecaceae


Fig. 5. Selected microbotanical remains. Phytoliths: q) Arecaceae globular echinate (Sed. Sample 3)
### Acrocomia sp.

#### Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>Leaf</th>
<th>Diagnostic phytoliths:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a) Conical echinate silica phytoliths. Very common.</td>
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<tr>
<td></td>
<td>Plane view</td>
</tr>
</tbody>
</table>

#### Leaf trunk

<table>
<thead>
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<th>Diagnostic phytoliths (*):</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Round psilate silica phytolith. Very common.</td>
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<tr>
<td>Assemblage</td>
</tr>
</tbody>
</table>

Scale bar = 20\(\mu\)m.

Acrocomia aculeata

Phytolith

A. Silicified cells of Acrocomia aculeata. ICN 0842.

Acrocomia media

Starch

Aiphanes deltoidea

Phytolith

G. Silicified cells of Aiphanes deltoidea. ICN 0242.

Ammandra decasperma

Phytolith

A. globular echinate symmetrical (Ammandra decasperma. ICN 0244).

Astrocaryum acaule

Phytolith

H. Silicified cells of Astrocaryum acaule. ICN 0245.

Astrocaryum chambira

Phytolith

B. Silicified cells of Astrocaryum chambira. ICN 0249.

Astrocaryum murumuru

Phytolith

Fig. 3. Phytoliths from non-grass monocots. c) Conical body from Astrocaryum murumuru

Attalea butyracea

Phytolith

B. globular echinate (Attalea butyracea. ICN 0255).
C. globular echinate elongate (Attalea butyracea. ICN 0254).

Attalea maripa

Phytolith

I. Silicified cells of Attalea maripa. ICN 0263.

Bactris-type

Phytolith

b. *Bactris*-type spinulose conical body diagnostic of the Arecaceae, but may be distinctive of certain palm genera such as *Bactris, Geonoma, Caryota,* and *Chamaedorea.*
c. *Bactris*-type in side-view.

Bactris sp.

Phytolith

Side view of body shows profile of two projections on top, smooth bottom surface. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Bactris sp.

Phytolith

There are several small spinulose spheres and other conical bodies in the background of this image. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Bactris sp.

Phytolith

You can spot several spinulose spheres and other conical bodies in the background of this image. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Bactris sp.

Phytolith

1. Hat-shaped silica bodies from Bactris (400 × ).

Bactris gasipaes var. gasipaes

Phytolith

C. Silicified cells of Bactris gasipaes var. gasipaes. ICN 0855

Bactris gasipaes

Starch

APPENDIX:
Bactris gasipaes (pejibaye, peach palm). Mostly simple grains, rarely compound, with slight depressions. Size: 4–14 microns long. Most palms contain few starch grains, which are unremarkable in shape, and very small. Size: 1–2 microns

Bactris killipii

Phytolith

F. Silicified cells of Bactris killipii. ICN 0858.

Bactris sphaerocarpa

Phytolith

G. conical (front view) (Bactris sphaerocarpa. ICN 0299).
H. conical (top view) (Bactris sphaerocarpa. ICN 0299).

Callamus hoorungii

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Caryota rumphiana
Chamaedora sp.

Phytolith

4. Hat-shaped silica bodies from Chamaedorea (400 × ).

Cocos nucifera

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Cocos nucifera

Australian Museum, McCown Archaeobotany Laboratory Collection
Spinulose spheres. Be sure to rotate to determine whether body is a sphere or conical body with spinulose projections. Diagnostic level: family, Arecaceae.
Drymophloeus beguinii

Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. C. Drymophloeus beguinii (Arecaceae), irregularly spherical bodies in vascular bundle-sheath cells (bar = 10 µm).

Euterpe oleracea

Phytolith

Fig. 3. Phytoliths from non-grass monocots. a) Globular echinate phytoliths from Euterpe oleracea, d) Stomata from E. oleracea leaf

Euterpe precatoria

Phytolith

E. Silicified cells of Euterpe precatoria. ICN 0865.

Geonoma atrovirens

Phytolith

D. Silicified cells of Geonoma atrovirens. ICN 0320.

Geonoma camana

Phytolith

i. globular echinate symmetric (Geonoma camana. ICN 0323).

Geonoma orbignyana

Phytolith

F. globular echinate with long acute projections (Geonoma orbignyana. ICN 0341).

Mauritia flexuosa

Phytolith

Fig. 3. Phytoliths from non-grass monocots. b) Globular echinate phytoliths from Mauritia flexuosa, e) Adaxial epidermis from M. flexuosa leaf

Metroxylon sagu

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Oenocarpus bataua

Phytolith

D. globular echinate with short acute projections (Oenocarpus bataua. ICN 0878).
E. reniform echinate (Oenocarpus bataua. ICN 0878).

Sabal minor

Phytolith

3. SEM photograph of a spherical, spinulose phytolith from Sabal minor (5000 x )

Sabal minor

Phytolith

3. Spherical, spinulose phytoliths from Sabal minor (650 x).

ASTERACEAE
Asteraceae

Phytolith

f. Opaque perforated platelet diagnostic of an Asteraceae inflorescence.

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. s) Asteraceae opaque perforated platelets (GM Profile 4 0-10 cm).

Fig. 5. Selected microbotanical remains. Phytoliths: r) Asteraceae opaque perforated plate (Sed. Sample 3)

Asteraceae

Phytolith

Be sure sheet is occluded and flat. Three dimensional, irregularly surfaced sheets are another type. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Bidens sp.

Phytolith

4. A segmented hair with squarish segments and thick cell walls from Bidens (400 x).

Calea urticifolia

Phytolith

1. A segmented hair from Calea urticifolia with a spherical base and thick cell walls (250 × ).

Eclipta alba

Phytolith

1. An armed segmented hair with an unarmed apex and base from Eclipta alba. The apex is not shown (400 X).

Elephantopus mollis

Phytolith

4. Non-segmented threadlike hairs from Elephantopus mollis. They have small, circular bases (125 x ).

Lipochaeta sp.

Phytolith

Asteraceae hairs tend to be armed. Compare to 40IIIBa201 Cucurbitaceae/Asteraceae hair and 40IIIBa202 Croton fraseri (Euphorbiaceae) hair. Diagnostic level: family
**Lipochaeta sp.**

**Phytolith**

Asteraceae hairs tend to be armed. Compare to 40IIIa201 Cucurbitaceae/Asteraceae hair and 40IIIa202 Croton fraseri (Euphorbiaceae) hair. May occur with some hairs segmented and unarmed: type 40IIIa201 (see lower right) Sometimes occluded as shown, or blackened.

Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lipochaeta sp.

Phytolith

Be careful of confusion with other Asteraceae multicellular hair types such as armed hairs (40IIIba1) and 40IIIba202, Croton fraseri (Euphorbiaceae) hair. Diagnostic level: Asteraceae/Cucurbitaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lipochaeta sp.

Phytolith

Asteraceae hairs tend to be armed. Compare to 40IIIBa201 Cucurbitaceae/Asteraceae hair and 40IIIBa202 Croton fraseri (Euphorbiaceae) hair. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lipochaeta sp.

Phytolith

Asteraceae hairs tend to be armed. Compare to 40IIBa201 Cucurbitaceae/Asteraceae hair and 40IIBa202 Croton fraseri (Euphorbiaceae) hair. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Melampodium camphoratum

Phytolith

Fig. 5. Phytoliths from dicotyledons. c) Hairbase from Melampodium camphoratum, d) Blocky polyhedrals from M. camphoratum

Melanthera hastata

Phytolith

2. An armed segmented hair with an unarmed apex from Melanthera hastata (250 x).

**Smallantus sonchifolius**

**Asteraceae *Smallanthus sonchifolius* “yacón”**

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>tuber</strong></td>
<td><strong>stem</strong></td>
</tr>
<tr>
<td>Non diagnostic twisted hairs. Segmented hairs, platelets and other (*).</td>
<td>No opal phytoliths (*).</td>
</tr>
<tr>
<td><strong>leaf</strong></td>
<td></td>
</tr>
<tr>
<td>Diagnostic hairs (*): a) Acute opaque silica hair. Different terminal bases. Very common.</td>
<td>b) Unciform opaque silica hair. Not common.</td>
</tr>
<tr>
<td>![Leaf images]</td>
<td>![Leaf images]</td>
</tr>
<tr>
<td>![Leaf images]</td>
<td></td>
</tr>
<tr>
<td>![Leaf images]</td>
<td></td>
</tr>
<tr>
<td><strong>flower</strong></td>
<td></td>
</tr>
<tr>
<td>Non diagnostic phytoliths (*): a) Acute opaque silica hair. Different terminal bases. Rare.</td>
<td>b) Acute translucent silica hairs. Rare.</td>
</tr>
<tr>
<td>![Flower images]</td>
<td>![Flower images]</td>
</tr>
<tr>
<td>![Flower images]</td>
<td></td>
</tr>
<tr>
<td>![Flower images]</td>
<td></td>
</tr>
<tr>
<td>c) Acute translucent silica hair. Different terminal bases. Not common.</td>
<td>d) Translucent stoma and epidermal silica cells. Rare.</td>
</tr>
<tr>
<td>![Flower images]</td>
<td>![Flower images]</td>
</tr>
<tr>
<td>![Flower images]</td>
<td>![Flower images]</td>
</tr>
</tbody>
</table>

Scale bar = 20μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Wulffia baccata

Phytolith

3. An armed segmented hair with an unarmed apex from Wulffia baccata (400 x). It is attached to the hair base.

BARRINGTONIACEAE
Barringtonia asiatica

Australian Museum, McCown Archaeobotany Laboratory Collection
BASELLACEAE
Anredera vesicaria

Starch

# Ullucus tuberosus

**Basellaceae Ullucus tuberosus “ulluco”**

## Phytolith assemblage characterization

<table>
<thead>
<tr>
<th><strong>Leaf</strong></th>
<th><strong>Flower</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic phytoliths (*):</td>
<td>No phytoliths (*).</td>
</tr>
<tr>
<td>a) Round to sub-round silica phytoliths with charcoal spots. Common.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Tuber</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non diagnostic phytoliths (*):</td>
</tr>
<tr>
<td>a) Rectangular irregularly cavate silica phytolith. Rare.</td>
</tr>
<tr>
<td>b) Rectangular psilate silica phytolith. Rare.</td>
</tr>
<tr>
<td>c) Sub-spherical irregularly cavate silica phytolith. Rare.</td>
</tr>
</tbody>
</table>

## Starch assemblage characterization

<table>
<thead>
<tr>
<th><strong>Tuber</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, globular or subglobular; less than 7μm.</td>
</tr>
<tr>
<td>b) Single grains, generally asymmetrical, variable in shape, irregular, prismatic, ovoid, oval, pear, bow- and bell-shaped, sometimes with one or more rounded projections and/or truncations in different parts, from 10μm to 30μm long length; highly eccentric distinct hilum as a circle or line; very distinct lamella, radiating lines from the hilum to the border of the grain; distinct eccentric cross to the rounded end, with sinuous, non-well definite dark arms intersecting at one point, fibrous appearance. May occur in aggregates.</td>
</tr>
<tr>
<td>c) Compound grains compounded by two-five granula. Granula generally unequal, with at less a symmetry axis.</td>
</tr>
</tbody>
</table>

**References:** Partially based on Cortella and Pochettino 1895.

Scale bar = 20μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
BATACEAE
Batis maritima

Phytolith

Unknown origin in tissue. Perhaps a cystolith with occluded fragments in interior. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
BIGNONIACEAE
Tecoma gandichianidi

Phytolith

Slide E101.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
BIXACEAE
Bixa orellana

Bixaceae  *Bixa orellana* “urucú or achiote”

### Phytolith assemblage characterization

**Diagnostic phytoliths**: a) Round or sub-rounded planar silicate phytolith. Very common.

#### Assemblage view.

**References**: Reported as not present in Piperno 1988:35 (it does not say which part of the plant was sampled).

### Starch assemblage characterization

a) Single grains, oval, subspherical, ellipsoidal, sausage-, and pear-shaped, sometimes with one or two truncations and a well-rounded opposite end; variable in size from 5μm to 37μm long length; sometimes distinct hilum; not visible lamella; mainly centric, but also eccentric cross, with four arms visible, intersecting at the center or meeting two by two.

b) Commonly compound grains, generally boomerang-shaped but also oval, without an external unique packing, compounded by two granula. Granula, variable in size and shape, typically bell-, bowl-shaped, and subquadrangular oblique, with a wavy or concave truncation at broader end; from 15μm to 37μm long length; distinct eccentric cross. Some compound grains, compounded by two sausage-shaped granula. Aggregates.

Scale bar = 20μm.
Bixa orellana

Starch

Bixa orellana

Phytolith

Diagnostic level under investigation. Observed in Bixa orellana (PC1691).

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Bixa orellana

Phytolith Diagnostic level under investigation. Observed in Bixa orellana (PC1691)

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Bixa orellana

Phytolith

Projections are not speculate, i.e., not 22VIII.
Not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Bixa orellana

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: fruit/seed
BOMBACACEAE
Ceiba sp.

Phytolith

PC2866, wood specimen
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Huberodendron patinoi

Phytolith

See top view (Record #155) of this body.
Not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Huberodendron patinoi

Phytolith

See side view (Record #154) of this body. Not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Huberodendron patinoi

Phytolith

Slide 1372a.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maltisia cf. alata

Phytolith

Nodular spheres occur in moderate levels in Maltisia cf. alata. Size range: 8 - 22 microns. Overlaps with Marantaceae nodular spheres. Marantaceae/Bombacaceae mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maltisia cf. alata

Phytolith

Nodular spheres occur in moderate levels in Maltisia cf. alata. Size range: 8 - 22 microns. Overlaps with Marantaceae nodular spheres. Marantaceae/Bombacaceae mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maltisia cordata

Phytolith

80IIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, Matisia cordata, Bombacaceae. Marantaceae/Bombacaceae mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maltisia cordata

Phytolith

80IIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, Matisia cordata, Bombacaceae. This image shows the rugulose bottom. Marantaceae/Cannaceae/Bombacaceae mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maltisia longipes

Phytolith

Stomate.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maltisia longipes

Phytolith

Note flat tip of hair. Occur rarely.
Slide 1366.
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maltisia longipes

Phytolith

Slide 1366 leaf.
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Ochroma pyramidalis

Phytolith

Category currently overlaps with Marantaceae nodular spheres.
Diagnostic level: Marantaceae/Bombacaceae
Ochroma pyramidalis

Phytolith

Category currently overlaps with Marantaceae nodular spheres. Diagnostic level: Marantaceae/Bombacaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pachira aquatica

Phytololith

Diagnostic level: family
Note the “corners” of the body, where angular structure cups rounded interior. When broken, forms 20VD. See also Record #147, 148 and 149. Note angular structure. From the bottom, it forms one stripe across length of back and two crossing body from side to side. In this top view, they appear as angular bands crossing.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Top view. Note attached filament. See also Record #146, 148 and 149. Angular structure that forms one stripe across length of back and two crossing body from side to side is not in focus in this view. Diagnostic level: family.
Pachira aquatica

Phytolith

Side view.
See also Record #146,147 and 149.
Diagnostic level: family
Note angular structure that forms one stripe across length of back and two crossing body from side to side. These appear in “top” of body as angular bands crossing subsidiary cells. In this side view they appear as angular

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pachira aquatica

Phytolith

Note the “corners” of the body, where angular structure cups rounded interior. When broken, forms 20VD.
Bottom view.
See also Record #146,147 and 148.
Note angular structure that forms one stripe across length of back and two crossing body from side to side. These are visible from “top” of body as angular

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pachira aquatica

Phytolith

Body is very faint. Notice y-shaped triangular cup around interior rounded part of body.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pachira aquatica

Phytolith

Body is very faint. This view shows the triangular rim.
Diagnostic level: family
Pachira aquatica

Phytolith

See alternate view (Record #153) to see bottom of hair cell base. Diagnostic level: genus
Pachira aquatica

Phytolith

Hair cell base, view of bottom. See image of hair cell base top also (Record #152).
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pachira aquatica

Phytolith

Slide 1367c. Diagnostic level: family
Note the “corners” of the body, where angular structure cups rounded interior.
When broken, forms 20VD See also Record #147, 148 and 149. Note angular structure. From the bottom, it forms one stripe across length of back and two crossing body

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pachira aquatica

Phytolith

Slide 1367c. Diagnostic level: family
Note the “corners” of the body, where angular structure cups rounded interior. When broken, forms 20VD See also Record #147, 148 and 149. Note angular structure. From the bottom, it forms one stripe across length of back and two crossing body from side to side. In this top view, they...
Pseudobombax millei

Phytolith

This is a verrucose cystolith encased in a short, broad trichome. Slide 813.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pseudobombax millei

Phytolith

Also occurs in the Zingiberaceae
Diagnostic level: mixed, Zingiberaceae, Bombacaceae. There are subtle
differences in the smoothness and abundance of nodules between the two families

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pseudobombax millei

Phytolith

Also occurs in the Zingiberaceae
Diagnostic level: mixed, Zingiberaceae, Bombacaceae. There are subtle differences in the smoothness and abundance of nodules between the two families.
Pseudobombax millei

Phytolith

Type is not diagnostic to Bombacaceae alone. Cystolith body may be very rugulose, verrucose, or nearly smooth. Diagnostic level: generalized arboreal.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pseudobombax millei

Phytolith

Small nodular spheres overlap with
Marantaceae Diagnostic level:
Marantaceae/Bombacaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pseudobombax millei

Phytolith

This is a verrucose cystolith encased in a short, broad trichome.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pseudobombax millei

Phytolith

Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pseudobombax millei

Phytolith

Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pseudobombax millei

Phytolith

Also occurs in the Zingiberaceae
Diagnostic level: mixed, Zingiberaceae, Bombacaceae. There are subtle differences in the smoothness and abundance of nodules between the two families.
Pseudobombax millei

Phytolith

Also observed in Matisia longipes leaf.
 Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Quarariba cf. grandifolia

Phytolith

See Record #171 to compare. Very broad obtuse tip (rarely pointed) and overall broad, short nature of hair distinguishes type. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Quarariba cf. grandifolila

Phytolith

Unusual because of it’s very dark, occluded rim and attached tissue. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Quararibea grandifolia

Phytolith

See size variation in cystoliths.
Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Quararibea grandifolia

Phytolith

See Record #170 to compare. Very broad obtuse tip (rarely pointed) and overall broad, short nature of hair distinguishes type. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Quararibea grandifolia

Phytolith

Schlerids occur widely in woody plants. Note distinctive central ridge in this body that identifies schlerids. Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
BORAGINACEAE
Cordia polyantha

Phytolith

Slide E1030.
Diagnostic level: species?

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith

Rotate to see rounded concavity in base where hair inserts. Slide 468 leaf. Type defined by Cesar Veintimilla 06/1991. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith

Diagnostic level: Cordia/Heliotropium

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith

Slide 468 leaf. Type defined by Cesar Veintimilla 06/1991. See also Record #108.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith

Occurs in leaf. Also occurs in Cordia lutea (fruit) and Heliotropium. Type defined by Cesar Veintimilla. Diagnostic level: Cordia/Heliotropium

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith Slide 468 leaf. Type defined by Cesar Veintimilla 06/1991. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia hebeclada

Phytolith

Occurs in leaf. Also occurs in Cordia lutea (fruit) and Heliotropium. Type defined by Cesar Veintimilla. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia lutea

Phytolith

These simple stomata are not diagnostic to family or even order level at this time.
Diagnostic level: not diagnostic
Cordia lutea

Phytolith

Diagnostic level: Cordia/Heliotropium

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia lutea

Diagnostic level: Cordia/Heliotropium

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia lutea

Phytolith

Type defined by Cesar Veintimilla
05/1991.
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia lutea

Phytolith

Side view.
See Cordia lutea hairs (40IIIAb100), conical bodies may come from projections on hair surface. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia lutea

Phytolith

Top view shows a Cordia lutea hair (40IIIAb100) with conical projections. Conical bodies (20VCd) may come from projections on hair surface. Diagnostic level (both): species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia lutea

Phytolith

See Record #112 for another view. See other Cordia lutea types (20VCd), conical bodies may be derived from hair surface. Type defined by Cesar Veintimilla 05/1991. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cordia lutea

Phytolith

Occurs in fruit. Type defined by Cesar Veintimilla.
Diagnostic level: species
Cordia lutea

Phytolith

Occurs in leaf. Also occurs in Cordia hebeclada (fruit) and Heliotropium. Type defined by Cesar Veintimilla. Diagnostic level: family
Cordia lutea

Phytolith

3. A silicified hair base from Cordia lutea showing the elliptical pore in the center. It is surrounded by silicified epidermal cells with spherical inclusions (250 x ).

Ehretia anacua

Phytolith

4. Non-segmented armed hair from Ehretia anacua. It is attached to the hair base (156×)

Hackelia mexicana

Phytolith

3. Segmented armed hairs with shortly divided segments near the base from Hackelia mexicana (156 × ).

Heliotropium angiospermum

Phytolith

Slide E227.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Heliotropium angiospernum

Phytolith

Slide E227. Several hair bases occur in picture next to unicellular hair (40IIIAb201). Concentric ring pattern not easily seen in picture. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Heliotropium angiospermum

Phytolith

Slide E227.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Heliotropium angiospermum

Phytolith

1. Silicified hair bases from Heliotropium angiospermum (250 x).

2. Silicified hair bases from Heliotropium indicum. Some have hair cells attached (250 x).
Lithospermum carolinense

Phytolith

Slide 1723a. Leaf. Hair tip

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723a. Leaf. Hair tip.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723a. Leaf. Hair with base

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723b. Leaf.
Hair with partial base attached and tip broken off.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723a. Leaf. Hair with base attached.
Diagnostic level: mixed Guazuma, Erythrina, Lithospermum

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723a. Leaf.
Diagnostic level: mixed Guazuma,
Erythrina, Lithospermum

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723c. Leaf.
Diagnostic level: mixed Guazuma, Erythrina, Lithospermum

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meaghan O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723c. Leaf.
Diagnostic level: mixed Guazuma, Erythrina, Lithospermum

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lithospermum carolinense

Phytolith

Slide 1723c. Leaf.
Partial hair base, shows radiating appendages.
Diagnostic level: mixed Guazuma, Erythrina, Lithospermum

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
BRASSICACEAE
**Brassicaceae  *Lepidium meyenii* “maca”**

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>tuber</strong></td>
</tr>
<tr>
<td>Different non diagnostic forms (*):</td>
</tr>
<tr>
<td>a) Semi-round irregular facetate</td>
</tr>
<tr>
<td>silica phytolith. Not common.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>b) Globose concave silica</td>
</tr>
<tr>
<td>phytolith. Not common.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>c) Spherical dense silica</td>
</tr>
<tr>
<td>phytolith. Rare.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>d) Lateral view of a round irregularly</td>
</tr>
<tr>
<td>perforated silica phytolith. Rare.</td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /> <img src="image2.png" alt="Image" /> <img src="image3.png" alt="Image" /> <img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>leaf attached to the tuber</strong></td>
</tr>
<tr>
<td>Different non diagnostic forms (*):</td>
</tr>
<tr>
<td>a) Bilobate psilate silica phytolith.</td>
</tr>
<tr>
<td>Rare.</td>
</tr>
<tr>
<td><img src="image5.png" alt="Image" /> <img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>b) Sub-rectangular irregularly</td>
</tr>
<tr>
<td>verrucate silica phytolith. Rare.</td>
</tr>
<tr>
<td><img src="image7.png" alt="Image" /> <img src="image8.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Scale bar = 20μm.
BROMELIACEAE
Abromeitiela sp.

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>leaf</td>
</tr>
<tr>
<td>Non diagnostic phytoliths (*):</td>
</tr>
<tr>
<td>a) Spherical centrally cavate silica phytolith. Common.</td>
</tr>
</tbody>
</table>

Scale bar = 20µm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Bromelia balanense

Phytolith

Spherical spinulose phytoliths from Bromelia balanense (400x).

# Tillandisia sp.

## Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>Phytolith Type</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
</table>
| **Leaf**      | Non diagnostic phytoliths (*):  
  a) Round silica phytolith.  
  Rare.  
  Lateral view.  
  Plane view.  
  b) Acuminate silica phytolith.  
  Rare.  
  | Reported as not present in Piperno 1988:27, on Tillandisia polystachya sample. |
| **Flower**    | Non diagnostic phytoliths (*):  
  a) Round central cavated silica phytolith.  
  Rare.  
  | Reported as not present in Piperno 1988:27, on Tillandisia polystachya sample. |
  b) Irregular silica phytolith.  
  Rare.  
  |

Scale bar = 20μm.
BURMANNIACEAE
Burmannia bicolor

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. m) Globular granulate phytolith from Burmannia bicolor

BURSERACEAE
Canarium indicum

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Dacryodes occidentalis

Phytolith

Slide 58. Also occurs in Trattinnickia glaziouii, slide 64. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Protium fimbriatum

Phytolith

See other rotations (Records 163 and 164) to get an idea of the three-dimensional shape. This body is very tall with a very ruffled or undulating edge. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Protium fimbriatum

Phytolith

See other rotations (Records 162 and 164) to get an idea of the three-dimensional shape. This body is very tall with a very ruffled or undulating edge. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Protium fimbriatum

Phytolith

See other rotations (Records 162 and 163) to get an idea of the three-dimensional shape. This body is very tall with a very ruffled or undulating edge. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Fig. 5. Phytoliths from dicotyledons. e) Stippled body from Protium guianense fruit, f-h) “Boney” bodies from P. guianense leaf

Trattinnickia glaziouii

Phytolith

Slide 64. Also occurs in Dacryodes occidentalis, slide 58. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trattinnickia glaziovii

Phytolith

Seed epidermis. Projection is not centered and may not be present on all fragments. The projection is often very low. Surface decoration not always evident unless focus is moved up and down.
Diagostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trattinnickia glaziovii

Phytolith

Seed epidermis. Projection is not centered and may not be present on all fragments. The projection is often very low. Surface decoration not always evident unless focus is moved up and down. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trattinnickia peruviana

Phytolith

Side view; see Record #134 for top view. Occurs in the leaf. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trattinnickia peruviana

Phytolith

Top view; see Record #133 for side view.
Occurs in the leaf. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trattinnickia peruviana

Phytolith

Top view; see Record #137 for side view. The small cells that overlay the large central cell appear as a “corona” when viewed from the side. Occurs in the leaf. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trattinnickia peruviana

Phytolith

Side view; see Record #136 for top view. The small cells that overlay the large central cell appear as a “corona” when viewed from the side. Occurs in the leaf. Large, 30-50 microns. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
CACTACEAE
Opuntia sp.

**Phytolith assemblage characterization**

<table>
<thead>
<tr>
<th>Diagnostic phytoliths (*)</th>
<th>Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Sub-spherical with central perforations silica phytolith. Common.</td>
<td><img src="image1.png" alt="Images" /> <img src="image2.png" alt="Images" /> <img src="image3.png" alt="Images" /> <img src="image4.png" alt="Images" /> <img src="image5.png" alt="Images" /></td>
</tr>
<tr>
<td>b) Sub-spherical silica phytolith. Common.</td>
<td><img src="image6.png" alt="Images" /> <img src="image7.png" alt="Images" /></td>
</tr>
</tbody>
</table>

References: Reported in Jones and Bryant 1992 for calcium oxalates.

Scale bar = 20μm.
CANNABACEAE
Celtis iguanea

Phytolith

Fig. 5. Phytoliths from dicotyledons. i) Hair base and polyhedral epidermal complex from C. iguanea leaf, j) Cystolith from Celtis iguanea, k) Stippled epidermis from C. iguanea seeds

Trema micrantha

Phytolith

1. Center, hair base from Trema micrantha with the remnants of armed hairs. Also present are non-segmented hairs (200 x ).

Fig. 4. A genus-specific phytolith from the fruit of Trema micrantha (Moraceae).

CANNACEAE
# Canna edulis

**Cannaceae**  
*Canna edulis* "achira"

## Phytolith assemblage characterization

**Leaf**
- Diagnostic phytoliths:  
  a) Spherical scrobiculate silica phytolith.  
  Abundant in chains or alone.  

**Pod**
- Non-diagnostics (*f*):  
  a) Reflected silica hair.  
  b) Rectangular narrow silica long cell with dense round spaces. Rare.  

**Starch assemblage characterization**
- a) Single grains, spherical and ovoid, sometimes with a truncate or wavy end with two acute projections, variable in size, commonly from 12μm to 15μm, but also to 20μm long length; sometimes indistinct, lightly eccentric hilum as a dot at not-truncated end; rarely indistinct lamella, distinct lightly eccentric cross, with four arms visible.  

**Seed**
- a) Single grains, ovoid, oval, teardrop-, bowl-, and kidney-shaped, sometimes having a truncated end with a typical lateral-rounded or central-acute projection, and an opposite well-rounded end, one face flat; variable in size, frequently over 100μm to 145μm long length; distinct, highly eccentric hilum, sometimes double; usually at the smaller truncated or projected end and slightly to the right or left of the longitudinal axis; very distinct lamella; distinct eccentric cross, with one, two, three or four visible arms.

**Tuber**
- Non-diagnostics (*f*):  
  a) Elongated irregularly silica phytolith situated with dense round spaces. Rare.

**References:**  


---

Korstanje and Babot,  
McCown Archaeobotany Laboratory Collection
Canna edulis

b. Angled and folded spheres from Canna edulis

Canna edulis

Figure 2. Phytoliths found in achira leaves (Canna indica L.). a) Major axis: 97.56 µm, minor axis: 82.44 µm; b) 31.26 µm, 10.45 µm; c) 36.1 µm, 9.99 µm; d) 38.58 µm, 14.19µm; e) 25.53µm, 24.91µm; f) 24.96 µm, 23.58 µm. Scale: 10 µm by 40X

Canna edulis

Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. A. Canna edulis (Cannaceae), druse-like silica bodies over vascular bundle sheath (bar = 10 µm).

Canna edulis

Phytolith

Spheres produced by Canna range from smooth to rugulose to irregularly angled or folded. Type 80IAa200 is based on an archaeological specimen of Canna edulis leaf, from the coast of Peru. Diagnostic level: Unknown. Does not occur in chemically extracted specimens; probably not silica.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna edulis

**Phytolith**

Large rugulose sphere (10-30 microns). Rugulose spheres occur in many taxa, such as the Marantaceae, Bombacaceae, Cannaceae, Heliconiaceae, and Chrysobalanaceae. Large spheres (10-30 microns) characterize Marantaceae and Cannaceae. Diagnostic level: Marantaceae/Cannaceae.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna edulis

Phytolith

Spheres produced by Canna range from smooth to rugulose to irregularly angled or folded. Type 80IAa201 is based on a modern specimen of Canna edulis leaf. Ephemeral spherical bodies are not included in this type. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna edulis

Phytolith

Canna produces smooth, rugulose, and irregularly folded and angled spheres. Diagnostic level (irregularly folded and angled): order Zingiberales

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna indica

Phytolith

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). A,D1-type druse with small fringe from Canna indica leaf. B, granular D2-type druse from Canna indica leaf. D, globular-micropapillate from Canna indica seed. Scale bars: A–J,M–Z=12 µm; K, L=5 µm

Canna indica

Phytolith

PC1390, leaf. Contrast irregularly angled and folded spheres (80IEa left above scale bar) and rugulose spheres (80IBb right above scale bar).
Canna indica

Starch

Fig. 9. Modern and unaltered Canna spp. starch grains comes from comparative species (Pagan-Jimenez, 2015): h-i, obovate starches (Canna indica, Ecuador).

Canna indica

Starch

Canna jaegeriana

Phytolith

Small rugulose spheres (< 10 microns) that are well silicified (i.e., opaque). According to Iriarte and Piperno, characteristic of woody dicots. Also occur in Canna and Marantaceae. Diagnostic level: woody dicot, with above qualification.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna sylvestris

Starch

Canna tuerckheimii (=edulis)

Phytolith

80IIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, Matisia cordata, Bombacaceae; VR in PC961 Canna tuerckheimii (epidermis) Marantaceae/Cannaceae/Bombacaceae e mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna tuerckheimii (=edulis)

Phytolith

80IIIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, Matisia cordata, Bombacaceae; VR in PC961 Canna tuerckheimii (epidermis) Marantaceae/Cannaceae/Bombacaceae e mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna tuerckheimii (=edulis)

**Phytolith**

PC961 (epidermis). Small nodular spheres, moderate in occurrence, variable in size and height of projections. This is a larger example, but smaller than 18 microns. Compare to 80Icc, 80Ica2. Overlaps with Marantaceae/Bombacaceae type.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna tuerckheimii (=edulis)

Phytolith

PC961 (epidermis). Nodular spheres moderate in occurrence, variable in size and height of projections. Compare to 80ICc, 80ICa2. Overlaps with Marantaceae/Bombacaceae type.
Canna tuerckheimii (=edulis)

Phytolith

PC2592, seed. Folded and angled spheres in situ in tissue. Typical size is 10-15 microns.
Diagnostic: Zingiberales

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna tuerckheimii (=edulis)

Phytolith

OS511, leaf. Chain of irregularly folded/angled spheres
Diagnostic: Zingiberales

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canna tuerckheimii

Starch

Fig. 9. Modern and unaltered Canna spp. starch grains comes from comparative species (Pagan-Jimenez, 2015): j, obovate starch (Canna tuerckheimii, Ecuador).

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). C,D1-type druse with fringe from Canna sp. rhizome. Scale bars: A–J,M–Z=12 µm; K, L=5 µm

Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. a-a2, Canna spp. obovate starch with rough surface (in a), with partial view of the hilum (or “h” in a-a1), with partial and diffuse view of the lamellae (or “L” in a1-a2), and pits (or “p”, in a2) over the surface when re-focused.
Canna sp.

Starch

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (http://www.missouri.edu/~phyto) for other photographs. j. Broken Canna starch granule, SS15 FS3290-A. k.

CHLORANTHACEAE
Hedyosmum sp.

Phytolith

2. Anticlinal epidermis from Hedyosmum (400 x).
3. Polyhedral epidermis from Hedyosmum (400 x).

Hedyosmum goudotianum

Phytolith

Note how robust and thick bodies are.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Hedyosmum goudotianum

Phytolith

Note that bodies are not flat or smooth in rotation. In this view, they are almost “puffed” and irregularly thick. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Hedyosmum goudotianum

Phytolith

Note large size of these polyhedral bodies.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Hedyosmum goudotianum

Phytolith

Note large size of these polyhedral bodies. See double outline of “plates” or faces on polyhedron. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
CHRYSOBALANACEAE
Chrysobalanus icaco

Phytolith


Fig. 2. Phytoliths with little or no taxonomic value. h) Hair base from Chrysobalanus icaco leaf
Chrysobalanus icaco

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: not diagnostic
Entered by Updated
Karol Chandler-Ezell 10/7/2002

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Chrysobalanus icaco

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: fruit/seed

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Hirtella carbonaria

Phytolith

Sphere, small. Often very difficult to notice in archaeological samples. Also produced in Canna, Bixa orellana. Diagnostic level: mixed: Chrysobalanaceae/Cannaceae/Bixa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Hirtella carbonaria

Phytolith

A very smooth example of 80IAa1 that appears to be two conjoined disks, as in the original description of the Chrysobalanaceae type by Piperno. Appear somewhat elongated. Chrysobalanaceae/Cannaceae mixed type.
A sheet of 80IAa1. Spheres are not completely smooth. Chrysobalanaceae/Cannaceae mixed type
Licania longistyla

Phytolith

Darkened cells in center of image.
Diagnostic level: dicot epidermis

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Licania longistyla

Phytolith

80IAa1 showing slight irregularity on edge. Slightly flattened in rotation. The irregularity can look like an inclusion until the sphere is rotated.

Chrysobalanaceae/Cannaceae mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Licania longistyla

Phytolith

Same 80IAa1 sphere as image Z2796 rotated to show the slight flattening and irregularity. Chrysobalanaceae/Cannaceae mixed type

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Licania macrophylla

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. n) Globular psilate phytolith from Licania macrophylla

Phytolith

Sphere, small. Often very difficult to notice in archaeological samples. Also produced in Canna, Bixa. Diagnostic level: mixed, Chrysobalanaceae/Canna/Bixa

Description
Parinari campestris

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. e) Thick, irregular polyhedrals from Parinari campestris

Clusia nemorosa

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. d) Decorated epidermis from Clusia nemorosa

COMBRETACEAE
Conocarpus erecta

Phytolith

COMMELINACEAE
Athyrocarpus peraecariefolium

Phytolith

1. A tongue-shaped phytolith from Athyrocarpus peraecariefolium (400 × ).

Commelina celestis

Phytolith

PC3154 leaf
Described by Neil Duncan. Common to abundant in this species and common in C. erecta. Larger and more hooked than similar Phaseolus hairs, but would be confusers where Commelina also grows. Diagnostic level: genus (in absence of Phaseolus)
Commelina celestis

Phytolith

PC3154 leaf
Described by Neil Duncan. Common to abundant in this species and common in C. erecta. Larger and more hooked than similar Phaseolus hairs, but would be confusers where Commelina also grows. Diagnostic level: genus (in absence of Phaseolus)

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database."[http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
PC3155, leaf
Described by Neil Duncan. The scallops on these schlerids are somewhat similar to those of Cucurbita spheres. The quadrilateral form distinguishes them. Common. Also common in C. robusta. Diagnostic level: not diagnostic
Commelina erecta

Phytolith

Type established by Karol Chandler-Ezell, 2004
C. erecta photos by Neil Duncan, 2011
Side view of flat domed rhizome cylinder, potential Calathea “confuser.” Note small size.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Commelina erecta

Phytolith

Type established by Karol Chandler-Ezell, 2004
C. erecta photos by Neil Duncan, 2011
Side view of flat domed rhizome cylinder, potential Calathea “confuser.” Note smaller size.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Commelina erecta

Phytolith

Type established by Karol Chandler-Ezell, 2004
C. erecta photos by Neil Duncan, 2011
Bottom view (base of ciliate or beaded cylinder) of flat domed rhizome cylinder

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Commelina erecta

Phytolith

Type established by Karol Chandler-Ezell, 2004
C. erecta photos by Neil Duncan, 2011
A group of cylinders in partial rotation; note decoration of base

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Commelina erecta

Phytolith

Type established by Karol Chandler-Ezell, 2004
C. erecta photos by Neil Duncan, 2011
A cylinder in partial rotation; note smooth, transparent head

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Commelina erecta

Phytolith

PC3157, leaf
Described by Neil Duncan. The scallops on these schlerids are somewhat similar to those of Cucurbita spheres. The quadrilateral form distinguishes them. Smaller, less robust, and rarer in this species. Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Commelina erecta

Phytolith

PC3157, leaf. Described by Neil Duncan.
Unicellular hairs. Rare to moderate abundance.
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Commelina scabra

Phytolith

PC3160, leaf Described by Neil Duncan. Unicellular hairs, more “hat-shaped” than the hairs in C. erecta. Diagnostic level: not diagnostic.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyanotis arachnoidea

Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. D. Cyanotis arachnoidea (Commelinaceae), small, spherical, spinulose bodies in epidermal cells, apparently following the cell wall (bar = 20 µm).

CONVULVULACEAE
Ipomoea batatas

Starch

Australian Museum,
McCown Archaeobotany
Laboratory Collection
### Ipomoea batatas

**Convolvulaceae Ipomoea batatas “batata”**

#### Phytolith assemblage characterization

| Root | References: Reported as not present in leaf and tuber (Piperno 1988:31). Reported as a family where phytoliths have been found to be not present, rare or not taxonomically significant (Pearsall 2000:371). Cristalline druses of calcium oxalate with no consistent shape; no raphides (Loy 1994). |

#### Starch assemblage characterization

<table>
<thead>
<tr>
<th>a) Single grains, ovoid, oval, polyhedral, bowl- and bell-shaped, sometimes with two or more facets; variable in size from 2.5μm to 55μm long length; mainly distinct eccentric hilum as a dot or line, usually at rounded or smaller end; distinct lamella; sometimes radiating fissures; very distinct margins; mainly distinct eccentric cross, with four arms visible. May occur in aggregates.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>b) Compound grains, compounded by two or more granula, without a single external packing. Granula variable in shape and size, polyhedral, bell- or bowl-shaped, with one or more facets, and plane, wavy or acute truncations; size from 2.5μm to 55μm; mainly distinct eccentric hilum as a dot or line; distinct lamella; sometimes radiating fissures; mainly distinct eccentric cross with four arms visible.</th>
</tr>
</thead>
</table>

| c) Another compound grains, with a single external package variable in shape, size, and number of granula. Granula variable in size to 20μm long length; very distinct hilum as a line or v-shaped; not visible lamella; distinct centric cross, with four arms visible. |

#### Scale bar = 20μm.
Ipomoea batatas

Starch

Starch grains from a modern sweet potato tuber. 80x

APPENDIX:
Ipomoea batatas (sweet potato) (Figure 2). Mostly compound grains, laminated, often with a diagnostic small and transverse fissure. The pressure facets have very distinct margins. Size: 4–34 microns long

Ipomoea batatas

Starch

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x,400x or 600x; scale bars: 20 mm). (c) Low magnification view of soil-stained dense material within ovate cell membranes (four) (c.f. parenchyma starch storage cells of Ipomoea batatas, Fig. 8c). (d) High magnification view of fragment of ovate cell showing densely packed starch grains (membrane has been lost) (c.f. parenchyma storage cells of I. batatas, Fig. 8c). Individual soil-stained starch grains are more easily seen in cells that are disintegrating than in intact cells because the grains are tightly packed in the latter.

Ipomoea batatas

Starch

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x, 400x or 600x; scale bars: 20 mm). (e, f) Faceted starch grains with central vacuole (c.f. starch grains of I. batatas, Fig. 8d, e). (f) Shows the grains in (e) viewed under cross-polarised light, showing central Maltese cross.

Ipomoea batatas

Starch

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x, 400x or 600x; scale bars: 20 mm).

(g) Soil-stained starch grain with central vacuole (c.f. starch grains of I. batatas, Fig. 8d). Although facets are not clearly visible, two straight edges of these are. (h) Xylem vessel element with alternate slit-like pits (c.f. xylem vessel element of I. batatas, Fig. 8f).

Ipomoea batatas

Starch

Fig. 8. Modern reference samples ((a, b mounted in Caedax; c–f mounted in glycerol jelly; 400x or 600x; scale bars: 20 mm). (c) Parenchyma storage cell of Ipomoea batatas root, with densely packed, immature starch grains. Storage cells are typically ovate, up to w115 mm diam., with thin walls, <0.5 mm thick. (d) Typical starch grains of I. batatas root. Grains are spherical to sub-spherical, often bell-shaped, up to w26 mm diam., with a vacuole at the central hilum (seen here as a dot) and up to six flattened pressure facets. Reichert (1913) described the hilum as “eccentrically placed. in or slightly to one side of the median line”. However, as this appears more or less central, to avoid confusion with the several Pacific starch taxa that have elongated grains with very eccentric hila (i.e. well off the median line, e.g. four of the five Remote Oceanic Dioscorea spp.), we describe the Ipomoea hilum as central, as did Loy et al. (1992). Many of the grains shown here are more mature than those in (c), hence are larger.

Ipomoea batatas

Starch

Fig. 8. Modern reference samples ((a, b mounted in Caedax; c–f mounted in glycerol jelly; 400x or 600x; scale bars: 20 mm). (e) Starch grains in left and upper right panels of (d) viewed under cross-polarised light, showing central Maltese crosses. (f) Xylem vessel element of I. batatas root. Vessel elements are up to c. 90 mm across with walls up to 5 mm thick, and alternate slit-like pits up to 20 mm across.

**Ipomoea batatas**

**Starch**

Fig. 2. Microfossils characteristic of introduced Ipomoea batatas root from Hamurana Rd (400? or 600?). (a, b) Clumps of immature, brown-stained starch grains in cellulose material (c.f. starch grains of I. batatas root, Fig. 4a-d). (c, d) Bell-shaped starch grains, one brown-stained, with central vacuole (arrows) (c.f. bell-shaped starch grains of I. batatas root, Fig. 4c). (e) Two brown-stained starch grains. The larger shows signs of corrosion: pitting and expansion of the vacuole (arrow). (f) Brown-stained starch grain showing extreme vacuole expansion (arrows).

Ipomoea batatas

Starch

Fig. 2. Microfossils characteristic of introduced Ipomoea batatas root from Hamurana Rd (400? or 600?). (g-j) Starch grains showing extreme swelling, and corrosion with cracking and disintegration. Vacuole (arrow) is visible in (g). A degraded xylem fragment with expanded wall pits (see below) is visible in (i).

Ipomoea batatas

Starch

Fig. 2. Microfossils characteristic of introduced Ipomoea batatas root from Hamurana Rd (400? or 600?). (k) Clump of starch grains showing variable swelling and disintegration. Note cracks (arrows). (The two dark-outlined objects top centre and left are air bubbles.) (l-p) Brown-stained xylem tracheary elements with slit-like pits (c.f. xylem vessel elements of I. batatas root, Fig. 4e-h). (n-p) show expansion of wall pits. In (l), the inside of the cell is visible through the large opening, lower end. (The other large object in o is a Cyathea fern spore.) Scale bars, 20 mm.

Ipomoea batatas

Starch

Fig. 3. Microfossils characteristic of introduced Ipomoea batatas root from Whangapoua (400? or 600?). (a) Well-preserved, multi-facetted starch grain with central vacuole (arrow) (c.f. multi-facetted starch grain of I. batatas root, Fig. 4d, bottom). (b) Starch grain is viewed under cross-polarised light, showing central Maltese cross, i.e., dark areas of cross-intersect in centre of grain (c.f. Fig. 4b). (c-k) Individual and pairs (f-h, j) of starch grains, showing brown-staining, facetting, central vacuole (arrows) and variable swelling. The vacuole in (f) is distorted length-wise.

Ipomoea batatas

**Starch**

Fig. 3. Microfossils characteristic of introduced Ipomoea batatas root from Whangapoua (400? or 600?). (a) Well-preserved, multi-facetted starch grain with central vacuole (arrow) (c.f. multi-facetted starch grain of I. batatas root, Fig. 4d, bottom). (b) Starch grain is viewed under cross-polarised light, showing central Maltese cross, i.e., dark areas of cross-intersect in centre of grain (c.f. Fig. 4b). (c-k) Individual and pairs (f-h, j) of starch grains, showing brown-staining, facetting, central vacuole (arrows) and variable swelling. The vacuole in (f) is distorted length-wise.

Ipomoea batatas

Starch

Fig. 3. Microfossils characteristic of introduced Ipomoea batatas root from Whangapoua (400? or 600?). (l-p) Brown-stained xylem tracheary elements with slit-like pits (c.f. xylem vessel elements of I. batatas, Fig. 4e-h). (l) and (m) are of the same specimen (a pair of elements: one wide and one narrow), photographed at different points and magnifications. (n) and (p) show cracks and pit expansion, respectively. Scale bars, 20 mm

Ipomoea batatas

Starch

Fig. 4. Microparts of Ipomoea batatas root from modern reference samples (400? and 600?). (a-d) Starch grains of various ages (mature grains are larger). Grains are colourless, spherical to sub-spherical, often bell-shaped, smooth, up to 26 mm in diameter, with a vacuole at the central hilum (arrows), and nearly all have one domed surface and up to six (rarely more than three) flattened pressure facets. Viewed from the top facets may be obscured with grains appearing completely round. In (b), grains in (a) are viewed under cross-polarised light, showing central Maltese crosses.

Fig. 4. Microparts of Ipomoea batatas root from modern reference samples (400? and 600?). (e-h) Xylem vessel elements. Elements are up to 90 mm across with walls up to 5 mm thick, and alternate slit-like pits up to 20 mm across. The vessel in (e) has been damaged during slide preparation. Starch grains in various concentrations are also visible. Scale bars, 20 mm

Ipomoea batatas

Starch

Fig. 6. Sweet potato starch grains from St. John and Eva 2. a, cluster of at least six starches possibly of sweet potato with smooth signatures associated to heat damaging in a low humidity environment; b and c, diagnostic polyhedral shapes with two to five pressure facets (“pf”), and diagnostic extinction crosses (b1, c1) consisting in two or three lightly curved-very thin arms with the fourth arm been wider and triangular; d, spherical starch showing the open hilum (“oh”) and lamellae (“L”) in the form of concentric rings. Provenances: starches a (artifact E-1), b and d (artifact E-2), c (artifact SJ-3)

Ipomoea batatas

Starch

Ipomoea cf. repanda

Starch

COSTACEAE
Chamaecostus cuspidatus

Phytolith

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–L), Heliconiaceae (J–V), and Lowiaceae (W–Z). E, non-fringed D1 (bottom arrow) and D2 (top arrow) druses from Chamaecostus cuspidatus leaf. Scale bars: A–J, M–Z=12 µm; K, L=5 µm

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). F, non-fringed D1 druse from Cheilocostus specious rhizome. I, side-view of Ta1 from Cheilocostus specious seed. Scale bars: A–J, M–Z = 12 µm; K, L = 5 µm

Costus englerianus

Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. B. Costus englerianus (Costaceae), druse-like silica bodies over bundle-sheath cells (bar = 20µm).

Costus lacerus

Phytolith

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). H, top-view of Ta1 (tabular-columellate) from Costus lacerus seed. Scale bars: A–J, M–Z=12 µm; K, L=5 µm

Costus pulverulentus

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). G, non-fringed D1 druse from Costus pulverulentus rhizome. Scale bars: A–J, M–Z = 12 µm; K, L = 5 µm

Dimerocostus uniflorus

Phytoliths with irregularly angled or folded surfaces from Dimerocoatus uniflorus (250x).

CUCURBITACEAE
3. A scalloped phytolith from *Calycophysum pedunculatum*. In contrast to *Cucurbita* it has irregular borders, shallow scallops, and usually only one decorated hemisphere.

4. An irregular, scalloped phytolith from *Cionosicys macrantha*. Its longest dimension is 44 m. Most of these phytoliths are flat, and they do not possess hemispheres with different scallop sizes.

Cionosicys macrantha

Phytolith

Fig. 16. Scalloped phytolith from a wild species in the Cucurbitaceae, Cionosicys macrantha (see caption for Fig. 15).

Cucurbita sp.

24. A Cucurbita phytolith from the pre-10,000 occupation at Vegas. It is 53 m long.
25. A Cucurbita phytolith from the assemblage directly dated to 9060 (Unit E 8–9, 110–120 cm below surface). It is 104 m long.
26. A Cucurbita phytolith from Vegas, same context as above. It is partially turned, revealing the hemisphere with smaller scallops. It is 80 m long.

Cucurbita sp.

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. I) Cucurbita scalloped sphere (P Ridged Field 2, 10-20 cm).

Cucurbita sp.

Fig. 5. Selected microbotanical remains. Phytoliths: m) Cucurbita sp. rind scalloped sphere (Sed. Sample 3)

Cucurbita sp.

Phytolith

Hair base. Central cell often not obvious unless phytolith is rotated. Cells are transparent, allowing you to look down or through the base. Diagnostic level: Asteraceae/Cucurbitaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cucurbita sp.

Phytolith

In some cases, base of hair is still inserted, making central cell very dark and obvious. Diagnostic level: Asteraceae/Cucurbitaceae
Cucurbita sp.

Phytolith

Number of joints varies. Diagnostic level: Cucurbitaceae/Asteraceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cucurbita sp.

Phytolith

Hairbase and attached cells form a large sphere. This particular base is darkened/occluded. Also visible in image:
A rotated, partial hairbase.
Diagnostic level:
Cucurbitaceae/Asteraceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
1. A spherical, deeply scalloped phytolith from *Cucurbita argyrosperma ssp. sororia* from Panama. Its longest dimension is 64 m.
2. A phytolith like the one in Figure 1 rotated so that the two different hemispheres can be seen.

Figure 12. A phytolith from *Cucurbita ficifolia*. One hemisphere has a grainy type of decoration (compare with Figures 2 & 13–16). It is 99 m long.

Cucurbita ficifolia

Phytolith

Fig. 1. Scalloped phytoliths from the fruit rind of the domesticated species Cucurbita ficifolia, native to Andean South America. The phytolith on the bottom is 125mm long.

Cucurbita ficifolia

**Phytolith**

Figure 3. Squash leaf phytoliths (Cucurbita ficifolia Bouché. a) 137.97µm, 20.58µm; b) 88.23µm, 16.3µm; c) 123.78µm, 23.78µm; d) 100.7µm, 21.48µm; e) 93.6µm, 18.54µm; f) 53.32µm, 13.64µm. Scale: 10 µm by 40X

Cucurbita ficifolia

Figure 4. Phytoliths from the epidermis of squash fruit (Cucurbita ficifolia Bouché). a) 23.25µm, 21.63µm; b) 47.97µm, 28.62 µm; c) 38.7µm, 23.86µm; d) 21.63 µm, 16.88 µm; e) 22.24µm, 21.26µm; f) 32.93 µm, 21.14 µm. Scale: 10 µm by 40X.

Cucurbita fiscifolia

Phytolith assemblage characterization

- **Rind.**
  - Diagnostic phytoliths:
    - a) Spherical faceted silica phytolith, Common.
    - b) Sub-spherical faceted opaque interior silica phytolith, Common.
    - c) Sub-spherical faceted cavate silica phytolith, Common.
    - d) Spherical marginal faceted silica phytolith, Common.
    - e) Segmented silica hair and hair base, Common.


Starch assemblage characterization

- **Rind.**
  - a) Single grains, variable in shape, oval, spherical, triangular with rounded sides and vortex, ovoid pear- and teardrop-shaped, variable in size, from 7µm to 35µm in length; not-visible hilum and lamella, a hollow at the center with similar shape to the contour of the grain; distinct centric cross with four arms visible, meeting at a dark ragged oval or circular hollow.

- **Pulp.**
  - a) Single grains, oval, and bell-shaped with a truncated concave-convex or concave-concave end, and a well rounded opposite one; variable in size from 10µm to 22µm in length; indistinct eccentric hilum as a dot at rounded end, sometimes distinct lamella; distinct eccentric to very eccentric cros, with four arms visible at the rounded end.
  - Some bunch aggregates.

- **Seed.**
  - a) Single grains, spherical, and polyhedral, variable in size from 5µm to 9µm in length; not-visible hilum and lamella, mainly centric cross, with four arms visible.

Scale bar = 20µm.
Cucurbita lundelliana

Phytolith

Fig. 12. A phytolith from Cucurbita lundelliana like the one in Fig. 11, turned on its side to reveal the different pattern of scallop shape and size on the hemispheres of Cucurbita phytoliths.

Cucurbita maxima

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruit</strong></td>
</tr>
<tr>
<td>Rnd.</td>
</tr>
<tr>
<td>Diagnostic phytoliths:</td>
</tr>
<tr>
<td>a) Sub-rounded faceted silica phytolith. Common.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Starch assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruit</strong></td>
</tr>
<tr>
<td>Rnd.</td>
</tr>
<tr>
<td>a) Single grains, variable in shape, oval, spherical, triangular with rounded sides and vortex, ovoid pear- and teardrop-shaped; variable in size, to 40μm long; non-visible hilum and lamella; a central hollow with similar shape to the contour of the grain; rough surface; distinct centric cross with four arms visible; meeting at dark oval or circular, sometimes ragged, hollow.</td>
</tr>
<tr>
<td>b) Also common spherical grains, to 12μm long length.</td>
</tr>
<tr>
<td><strong>Pulp.</strong></td>
</tr>
<tr>
<td>a) Single grains, spherical to oval, bowl- and sausage-shaped; sometimes truncated; variable in size from 2μm to 12μm long length; not visible hilum and lamella; distinct centric or lightly eccentric cross, with four arms visible.</td>
</tr>
<tr>
<td>a) Mainly single grains, spherical to oval, and bowl-shaped, with a truncated wavy concave-convex or convex end; variable in size from 2μm to 6μm long length; not visible hilum and lamella; distinct centric cross, with four arms visible.</td>
</tr>
<tr>
<td><strong>Seed.</strong></td>
</tr>
<tr>
<td>b) Some compound grains, oval and teardrop-shaped, compounded by three or four granula, and compound grains, irregular in shape, compounded by variable number of granula. Granula different in size and shape, with one or two oblique truncations. Aggregates.</td>
</tr>
</tbody>
</table>

Scale bar = 20μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Cucurbita mixta

<table>
<thead>
<tr>
<th>Cucurbitaceae</th>
<th>Cucurbita mixta “angola”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phytolith assemblage characterization</strong></td>
<td></td>
</tr>
<tr>
<td><strong>fruit</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Rind.</strong> Non diagnostic phytoliths:</td>
<td></td>
</tr>
<tr>
<td>a) Round granulate silica phytolith. Very common.</td>
<td></td>
</tr>
<tr>
<td>b) Polyhedral sub facetate silica phytolith. Common.</td>
<td></td>
</tr>
<tr>
<td>c) Sub-spherical opaque interior silica phytolith. Common.</td>
<td></td>
</tr>
</tbody>
</table>

Scale bar = 20μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Cucurbita moschata

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
**Cucurbita moschata**

*Starch assemblage characterization*

<table>
<thead>
<tr>
<th>Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, spherical and polyhedral; variable in size from 3μm to 10μm long length; indistinct or distinct centric hilum as a dot or circle; not-visible lamella; distinct centric cross, with four arms visible.</td>
</tr>
</tbody>
</table>

| References: Partially based on Piperno and Holst 1998. |

Scale bar = 20μm.
13. A phytolith from a Venezuelan population of *C. moschata*. It is thicker (72 m) than it is long (58 m) and possesses a clear demarcation between the two hemispheres. It also has elongated scallops on one hemisphere.

14. A scalloped phytolith from a Venezuelan population of *C. moschata*, in which the hemisphere with the smallest scallops is greatly reduced or truncated. These have only been observed thus far in *C. moschata*. It is 56 m long.

15. Scalloped phytoliths from *C. moschata* from western Ecuador. They differ from those in the Venezuelan land race of *C. moschata* (compare with Figures 13 & 14). The largest phytolith is 102 m long.

16. A scalloped phytolith from *C. moschata* from Vera Cruz, Mexico. It is 60 m long.

Cucurbita moschata

Phytolith

Fig. 5. Scalloped phytoliths from the domesticated species Cucurbita moschata. Wild squash phytoliths have the same morphology but are often much smaller than in domesticates. From Piperno, 2006

Fig. 2. Scalloped phytoliths from the domesticated species *Cucurbita moschata*. They have the same morphology as those in Fig. 1, but are larger than in *C. sororia* and other wild species. hh: hypodermal hemisphere, mh: mesocarpal hemisphere. Reprinted from Piperno et al. (2002), Copyright National Academy of Sciences USA.

Cucurbita moschata
Phytolith

Figures 17 and 18. Irregular scalloped phytoliths from the bitter *C. moschata* from Panama. Both are about 40 m long.

Cucurbita moschata

Phytolith

Fig. 11. A spherical, scalloped phytolith from the rind of Cucurbita moschata. The scallops are round, deep, and regularly distributed.

Cucurbita moschata

Phytolith

Fig. 9. A phytolith from a fruit rind of Cucurbita moschata recovered from Huaca Prieta, Peru. It is like those found in modern fruits of the crop. The longest dimension of the phytolith measures 66 mm.

Fig. 10. A phytolith from a fruit rind of Cucurbita moschata from Huaca Prieta, Peru. It has attributes unlike in phytoliths from modern fruits. The longest dimension is 54mm.

APPENDIX:
Cucurbita moschata (squash). Mostly simple grains, round to bell-shaped. When turned they may have the appearance of a hollow cone. The hilum is a closed point and is frequently surrounded by very prominent lamella. The distal end of the grains tends to be pleated. Size: 8–24 microns long.

Cucurbita palmata

Phytolith

1. A segmented hair from Cucurbita palmata (200 x ).

Cucurbita pepo

Phytolith

4. Segmented hair from Cucurbita pepo with two segments and a small, round apical segment (250x).

1. Segmented hair from Cucurbita pepo with a somewhat tapered basal and intermediate segment and a small, rounded apical segment (250 x). Many hairs of this type have less tapered basal and intermediate segments.

Cucurbita pepo

Phytolith

2. A broken segmented hair from Cucurbita pepo (250 ×).
3. A segmented hair from Cucurbita pepo (156 x).

Cucurbita pepo var. ozarkana

Phytolith

Diagnostic level: genus, domesticated
Larger hemisphere of spheres is visible in this view.
See Piperno’s 2000 Journal Archaeological Science article: “Phytoliths in Cucurbita and other neotropical Cucurbitaceae .....” for extensive discussion of the spheres produced by this family.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cucurbita pepo var. ozarkana

Phytolith

Diagnostic level: genus, domesticated In this view, you can see the difference between “large” and “small” hemispheres

See Piperno’s 2000 Journal Archaeological Science article: “Phytoliths in Cucurbita and other neotropical Cucurbitaceae .....” for extensive discussion of the spheres produced by this family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Gurania makoyana

Phytolith

2. A segmented hair from Gurania makoyana (250 x ).
3. A segmented hair with long segments and a non-tapered shaft from Gurania makoyana (250 X ).

**Lagenaria siceraria**

<table>
<thead>
<tr>
<th>Cuticle Features: Lagenaria siceraria “male”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physolith Assemblage Characterization</strong></td>
</tr>
<tr>
<td>a. Acuminate segmented translucent</td>
</tr>
<tr>
<td>silica hairs. Very common.</td>
</tr>
<tr>
<td>b. Silica epidermal cells. Not common.</td>
</tr>
<tr>
<td>c. Acuminate segmented translucent silica</td>
</tr>
<tr>
<td>hairs with different ends in the hair</td>
</tr>
<tr>
<td>base. Common.</td>
</tr>
</tbody>
</table>

**References:** Reported in Pirrie 1985.

<table>
<thead>
<tr>
<th>Stem Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Acuminate segmented silica hairs. Rare.</td>
</tr>
<tr>
<td>b. Semispherical granulate irregular</td>
</tr>
<tr>
<td>faceted silica physolith. Not common.</td>
</tr>
</tbody>
</table>

**References:** Reported in Buzeth 1987, Pirrie 1985.

<table>
<thead>
<tr>
<th>Starch Assemblage Characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Single grains, spherical, oval and bowl-</td>
</tr>
<tr>
<td>shaped; variable in size from 10μm to 20μm</td>
</tr>
<tr>
<td>long length; not visible hilum and lamella;</td>
</tr>
<tr>
<td>distinct centric cross, with four arms</td>
</tr>
<tr>
<td>visible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulp Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Single grains, spherical, oval, and spherical with a little point projection or transverse facets; variable in size from 3μm to 17μm long length; not visible hilum and lamella; distinct centric or slightly eccentric cross, with four arms visible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rind Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Compound grains, with a polyhedral package four- to five-sided, some elongated; variable in size, to 225μm long length; compounded by many granula different in size. Granula with very distinct centric hilum as a circle or oval; not visible lamella; distinct centric cross, with four arms visible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seed Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Single grains, spherical and oval, sometimes faceted; variable in size from 8.5μm to 25μm long length; distinct hilum as an as clear spot with a round cavity; not visible lamella; sometimes reticulating features; distinct centric cross, with four arms visible.</td>
</tr>
</tbody>
</table>

Scale bar = 20μm.
Lagenaria siceraria

Phytolith

d. Scalloped sphere from Lagenaria siceraria.

Lagenaria siceraria

Phytolith

9. A phytolith from bottle gourd. It is hemispherical with elongated scallops.
10. A hemispherical phytolith from bottle gourd, with its undecorated flat side laying face up. The scallops are irregularly shaped.
11. A hemispherical phytolith from bottle gourd, with irregularly shaped and elongated scallops.
28. A bottle gourd phytolith from pre-7000 contexts at the Aguadulce rock shelter. It is hemispherical and has irregular, elongated scallops (compare with Figure 10).

Lagenaria siceraria
Phytolith

Fig. 6. Scalloped phytoliths from bottle gourd. Unlike in Cucurbita, scallops are irregularly-shaped and one hemisphere of the phytolith is flat and undecorated. Size ranges from 64 to 112 mM. From Piperno, 2006.

Lagenaria siceraria

Phytolith

Fig. 13. A phytolith from Lagenaria siceraria (bottle gourd). It is distinctive because it has large, often elongated, and irregularly distributed scallops on one side of the phytolith, and is hemispherical.

Lagenaria siceraria

Phytolith

Fig. 4. A phytolith from bottle gourd showing how the irregular pattern of the stone cells is discernible on the phytolith surface

Lagenaria siceraria

Phytolith

Diagnostic level:
Cucurbitaceae/Asteraceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lagenaria siceraria

Phytolith

The presence of elongated facets/scallops, that are irregularly distributed, are the diagnostic features of gourd. See Piperno et al. 2000. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lagenaria siceraria

Phytolith

The presence of elongated facets/scallops, that are irregularly distributed, are the diagnostic features of gourd. See Piperno et al. 2000. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lagenaria siceraria

Phytolith

4. A segmented hair from Lagenaria siceraria (200x).

**Luffa astori**

**Phytolith**

1. Irregular, lumpy pieces of silica from *Luffa astori* (250 × ).

Melothria guadalupensis

Phytolith

2. Segmented hairs with circular segments and tapered apexes from Melothria guadalupensis (156 x ).

Melothria guadalupensis

Phytolith

1. Segmented hairs with the surface decoration of long, fine striations from Melothria guadalupensis (156 x ).

Peponopsis adhaerens

Phytolith

5. A scalloped phytolith from *Peponopsis adhaerens*. It has shallow scallops and possesses only one decorated hemisphere. It is 44 m long.

Phytolith

Fig. 15. Scalloped phytoliths from a wild species in the Cucurbitaceae, Peponopsis adhaerens. They differ from domesticated Cucurbitaceae in having small and indistinct scallops, little difference in the decoration of the hemispheres, and in overall size. Also, they often are not spherical, but are flattish (see also Fig. 16).

Pittiera grandiflora

Phytolith

4. Segmented hairs from Pittiera grandiflora. Some have blackish silica inclusions (156 x).

2. A hair base from *Pittiera grandiflora* consisting of two half-spheres joined together (400 x).

APPENDIX:

6. A phytolith from *Sicana odorifera* rotated so that the differences in the shapes and decorations of the two hemispheres can be observed. The hemisphere on the left forms a cone and it also has a different surface decoration than that of *Cucurbita* (compare with Figures 1 & 2).

7. A phytolith from *Sicana odorifera*. The undecorated hemisphere is laying face up. Notice the dark margin of the phytolith (compare with Figure 1).

8. A phytolith from *Sicana odorifera* showing how the hemispheres are asymmetrical.

Sicana odorifera

Phytolith

Fig. 14. A phytolith from Sicana odorifera. It has one hemisphere that is markedly conical and faintly decorated (compare with Cucurbita and Lagenaria).

Sicyos echinocystoides

Phytolith

3. Segmented hairs from Sicyos echinocystoides (156 × ).
4. A segmented hair from Sicyos echinocystoides (156 x ).

CYATHEACEAE
Cyathea pallescens

Phytolith

Slide 2229a. Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyathea pallescens

Phytolith

Slide 2229a. Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyathea pallescens

Phytolith

Slide 2229a. Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyathea pallescens

Phytolith

Slide 2229a. Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyathea pallescens

Phytolith

Slide 2229a. Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyathea pallescens

Phytolith Slide 2229a. Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyathea pallescens

Phytolith

Slide 2229a. Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyathea pallescens

Phytolith

Slide 2229a. Leaf
CYPERACEAE
Cyperaceae

Phytolith

h. Achene phytolith highly distinctive, and possibly diagnostic of the Cyperaceae genera *Kyllinga* and *Cyperus*.

Cyperaceae

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. i) Cyperaceae hat-shaped phytolith with satellites (BD M1, 20-30 cm).

Abildgaardia monostachya

Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. B. Abildgaardia monostachya (Cyperaceae), conical bodies with satellites in epidermis (bar = 10 µm).

Carex intermedia

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. A. Carex intermedia (Cyperaceae), lateral view of a conical silica body with tiny spines projecting near the base (bar = 10 µm).

Cyperus articulatus

Phytolith

Fig. 3. Phytoliths from non-grass monocots. g) Polygonal cone from Cyperus articulatus achene

3. Conical-shaped phytoliths from *Cyperus chorizanthus* (400×).

Cyperus esculentus

Phytolith

PC628, leaf
Often occur in lines or ranks. Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC628, leaf
Often occur in lines or ranks. Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC629 inflorescence
Some examples have edge
projections Diagnostic level: under
study
Cyperus esculentus

Phytolith

PC629 inflorescence
Some examples have edge projections. This photo shows a side view.
Diagnostic level: under study.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC629 inflorescence
Some examples have edge projections. This photo shows edge projections.
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC629 inflorescence Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC629 inflorescence
This example (viewed from the bottom) has edge decoration/projections
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC626, leaf
Often occur in lines or ranks.
Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC626, leaf
Often occur in lines or ranks.
Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC627 inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC627 inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus esculentus

Phytolith

PC627 inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus hermaphroditus

Phytolith

PC2996 leaf
Epidermal sheet with 20VA in situ
Often occur in lines or ranks.
Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus hermaphroditus

Phytolith

PC2996 leaf
Side view of group of 20VA
Often occur in lines or ranks.
Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus hermaphroditus

Phytolith

PC2997
This variant has flat-topped rather than conical projections. Both flat and conical are present in the specimen; flat tend to occur in epidermal sheets
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus hermaphroditus

Phytolith

PC2997
This variant has flat-topped rather than conical projections. Both flat and conical are present in the specimen; flat tend to occur in epidermal sheets
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus hermaphroditus

Phytolith

PC2997
This variant has flat-topped rather than conical projections. Both flat and conical are present in the specimen; flat tend to occur in epidermal sheets
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus hermaphroditus

Phytolith

PC2996, leaf
double-outline trichome
Not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Cyperus hermaphroditus

Phytolith

PC2997, inflorescence double-outline trichome
Not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. j) Cyperus/Kyllinga achene body (BD M1, 10-20 cm).

Kyllinga brevifolia

Phytolith

Fig. 3. Phytoliths from non-grass monocots. h) Polygonal cone from Kyllinga brevifolia achene

Remirea maritima

Phytolith

Fig. 3. Phytoliths from non-grass monocots. i) Polygonal cone from Remirea maritima achene

Rhynchospora gigantea

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. f) Trichome from Rhynchospora gigantea inflo

Rhynchospora gigantea

Phytolith

Fig. 3. Phytoliths from non-grass monocots. f) Cones from Rhynchospora gigantea inflo, k) Polygonal cone from R. gigantea achene

Scirpus sp.

Phytolith

Fig. 5. Selected microbotanical remains. Phytoliths: t) Scirpus achene (LM 99-1864).

Scirpus sp.

Phytolith

Epidermal seed phytolith
The genus Scirpus is distinct for its very tall conical projection and tall, pointed “sombrero” appearance.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Scirpus sp.

Phytolith

The genus Scirpus is distinct for its very tall conical projection and tall, pointed “sombrero” appearance.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. k) Scirpus-type achene body (BD M1, 0-10 cm).

Scirpus asper

Phytolith

Fig. 3. Phytoliths from non-grass monocots. j) Polygonal cone from Scirpus asper achene

Scirpus totora

Phytolith

PC644 leaf
Epidermal sheet with 20VA in situ
Often occur in lines or ranks.
Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Scleria eggersiana

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. c) Anticlinal epidermis from Scleria eggersiana inflo

Torulinium odoratum

Phytolith

Often occur in lines or ranks.
Often conical in top view, but non-quadrilateral in side view.
In side view, conical projections with “shoulders”.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Torulinium odoratum

Phytolith

Often occur in lines or ranks.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
DASYPOGONACEAE
Dasypogon bromeliifolius

Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. J. Dasypogon bromeliifolius (Dasypogonaceae), epidermal silica sand (bar = 20 µm).

Kingia australis

Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. H. Kingia australis (Dasypogonaceae), spherical silica bodies with a rugose surface in epidermal cells (bar = 10 μm).

DICHAPETALACEAE
Stephanopodium longipedicellatum

Phytolith

Very variable in appearance, recognizable by the twisted appearance with smooth concave curves next to angular plate junctions. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stephanopodium longipedicellatum

Phytolith

Dichapetalaceae family diagnostic type. Surfaces angled, platelike, yet curving. Dichapetalaceae type has 3 broad branches, surface grainy while other types have thin or pointed branches. Diagnostic level: family
Stephanopodium longipedicellatum

Phytolith

Dichapetalaceae family diagnostic type.
Surfaces angled, platelike, yet curving.
Dichapetalaceae type has 3 broad branches, surface grainy while other types have thin or pointed branches.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stephanopodium peruvianum

Phytolith

Very variable in appearance, recognizable by the twisted appearance with smooth concave curves next to angular plate junctions.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Tapura peruviana

Phytolith

Very variable in appearance, recognizable by the twisted appearance with smooth concave curves next to angular plate junctions. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Tapura peruviana

Phytolith

schlerid
This shows a typical elongate schlerid.
Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Tapura peruviana

Phytolith

schlerid
This shows a very short, broad, curved example.
Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
DILLENIACEAE
Dilleniaceae

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. r) Dilleniaceae-type hair base phytoliths (GM RP, 0-15 cm)

Curatella americana

Phytolith

Fig. 5. Phytoliths from dicotyledons. l) Trichomes from Curatella americana, m) Hair base from C. americana

Curatella americana

Phytolith

3. A short, deltoid hair cell phytolith with prongs from Curatella americana (400 x)

Curatella americana

Phytolith

4. Silicified multicelled hair bases from Curatella americana. They are attached to silicified polyhedral epidermis (250 x ).

Davilla alata

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. b) Anticlinal epidermis from Davilla alata leaf

Davilla aspera

Phytolith

4. Non-segmented hair cell phytoliths from Davilla aspera. The hair in the center has prongs and lateral projections at the base (125 x ).

Davilla rugosa

Phytolith

1. Non-segmented hair cell phytolith with prongs and lateral projections from Davilla rugosa (250 X).

Tetracera volubilis

Phytolith

1. Silicified multicelled hair base with 4 cells from Tetracera volubilis (250 × ).

DIOSCOREACEAE
Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. e, cf. Dioscoreaceae starch with various concentric rings or lamellae around the hilum and with concentric layers or lamellae (“L”) going down to the distal end; e1, the same starch showing its extinction cross.

Dioscorea alata

Australian Museum, McCown Archaeobotany Laboratory Collection
Dioscorea alata

Australian Museum, McCown Archaeobotany Laboratory Collection
Dioscorea altissima

Starch

Dioscorea altissima

Starch

Dioscorea bulbifera

Starch

Dioscorea bulbifera

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Dioscorea esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Dioscorea esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Dioscorea nummulania

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Dioscorea pentaphylla

Australian Museum,
McCown Archaeobotany Laboratory Collection
Dioscorea polygonoides

Starch

Starch

Starch grains from a modern tuber of Dioscorea trifida. 80x

APPENDIX:
Dioscorea trifida (yampi’) (Figure 3). Simple grains, laminated, with a more or less distinct point where the hilum is located. They possess a cuneiform-shaped depression extending from the hilum to the bottom of the grain, and a straight distal edge. Size: 24–84 microns long

Dioscorea trifida

Starch

Dioscorea trifliola?

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Dioscorea sp.

Starch

Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. a: Starch granule of Dioscorea sp. recovered from flake 3.

Dioscorea sp.

Starch

Dioscorea sp.

Dioscorea sp.

Starch

Fig. 5. Selected microbotanical remains. Starch grains: c) Dioscorea sp. (SAL 04-2-7447)

Dioscorea sp.

Starch

![Starch grain](image)

Figure 1. Various starch grains. c, A starch grain from a species of Dioscorea recovered from milling stone 350. Scale bar 10 µm

Dioscorea sp.

Starch

Fig. 2. Selected archaeological starch grains. (D) Dioscorea cf. urophylla starch from Trapiche, chopper 147/10, ?4300 cal BP (under cross-polarized light). (H) Dioscorea sp. starch from Ladrones, handstone CL-68/1, ?7500 cal BP. (Scale bar: 10 µm.) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8

Dioscorea sp.

Phytolith

Diagnostic level: root/tuber

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Dioscorea sp.

Phytolith

Diagnostic level: root/tuber

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Dioscorea sp.

Phytolith

Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Dioscorea sp.

Phytolith

Diagnostic level: root/tuber

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
EBENACEAE
Diospyros virginiana

Phytolith

Faceted hemisphere, side view (see Record #177 for top view).
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Diospyros virginiana

Phytolith

Faceted hemisphere, top view (see Record #176 for side view).
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Diospyros virginiana

Phytolith

Note interesting “ridge” of bumps gives it a scalloped appearance on the dorsal ridge.
Diagnostic level: generalized arboreal
ELAEOCARPACEAE
Sloanea grandiflora

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. I) MFB from Sloanea grandiflora leaf

ERICACEAE
Macleania sp.

Phytolith

Very large schlerid.
Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Macleania sp.

Phytolith

Very large schlerid.
Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
ERITHROXELACEAE
Erythroxylum coca

<table>
<thead>
<tr>
<th>Erithroxelaceae Erythroxylum coca “coca”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phytolith assemblage characterization</strong></td>
</tr>
<tr>
<td>a) Tetracuneiform calcium oxalates phytoliths. Very common.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Image" /> <img src="image2" alt="Image" /> <img src="image3" alt="Image" /> <img src="image4" alt="Image" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Starch assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, oval to spherical, well rounded; variable in size from 10μm to 30μm long length; not-visible hilum and lamella. Some bunch aggregates.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Image" /></td>
</tr>
</tbody>
</table>

Scale bar = 20μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Erythroxylum mucronatum

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. k) Sclereid from Erythroxylum mucronatum

EUPHORBIACEAE
Acalypha diversifolia

Phytolith

Diagnostic level: not diagnostic
Acalypha diversifolia

Phytolith

Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Amanoa anomala

Phytolith

Be sure to rotate blocky quadrilaterals to see the distinct nature of the projections in this type.
See other Euphorbiaceae taxa to see range of variation of this type across the family.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Amanoa anomala

Phytolith

Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Amanoa anomala

Phytolith

View of rounded side... projections not visible, facets not distinct in this view. Be sure to rotate to see both views. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Croton fraseri

Phytolith

This type is not diagnostic of Euphorbiaceae. It is produced in a number of dicots. May occur singly or in sheets of different sizes. This is a particularly large sheet. May be occluded. Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Croton fraseri

Phytolith

Blocky quadrilateral epidermal tissue. In profile, projections and facets on multifaceted face give crown-like appearance. Rotate to spot multifaceted space and distinguish from non-diagnostic 3D epidermal blocks. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Croton fraseri

Phytolith

Blocky quadrilateral. This example is more flattened than usual, showing range of the type.
Diagnostic level: family
Croton fraseri

Phytolith

Can have roughened edges, but many examples are smooth. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Manihot esculenta

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Manihot esculenta

**Phytolith**

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Manihot esculenta

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Manihot esculenta

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
1. A stellate hair cell from Manihot esculenta (250 x ).

Manihot esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Manihot esculenta

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Manihot esculenta

Fig. 1. Light micrographs of coastal Peruvian (A, B) and lowland (C, D) types of manioc starch granules showing distinctive and diagnostic features of each. All photographs are at the same magnification.

A. Starch granules of manioc roots from Chimu Sur. Note the typical hemispherical forms with linear central fissuring.

B. Coastal Peruvian starch granules from modern manioc roots with typical Peruvian form. Note the smaller overall size and less “inflated” quality of hemispherical granules compared to lowland types.

C. Modern manioc starch granules from roots from the Upper Rio Negro region of Venezuela. Note the large, central stellate fissure and hollow hilum.

D. Compound starch grain of lowland manioc showing how basal faceting occurs during development as small granules form with the larger granule. Note the inflated quality of the large, diagnostic granule.

Manihot esculenta

Starch

Starch grains from a modern manioc tuber. 80x.

APPENDIX:
Manihot esculenta (manioc, yuca). Mostly compound grains, with very characteristic bell shapes and smooth surfaces. They are not demonstrably laminated. They often possess a diagnostic central fissure that is deep and stellate. Size: 5–20 microns long

Manihot esculenta

Starch

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (http://www.missouri.edu/~phyto) for other photographs. i. Manihot esculenta starch granule, SS42 FS3294-B.


Fig. 5. Selected microbotanical remains. Starch grains: b) Manihot esculenta (SAL 04-4-3597)
Manihot esculenta

Starch

Figure 1. Various starch grains. a, A starch grain from manioc recovered from milling stone 42. b, A starch grain from the putative wild ancestor of manioc, Manihot esculenta spp. flabellifolia. Scale bar 5 µm

Manihot esculenta

Starch

Fig. 2. Selected archaeological starch grains. (B) Manioc (Manihot esculenta) starch from Casita de Piedra, grinding-stone base 69/18, ?3600 cal BP. (Scale bar: 10 µm) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.

Manihot esculenta

Starch

Manihot esculenta

Phytolith

c. Hair cell base from manioc, Manihot esculenta

Manihot sp.

Phytolith

Fig. 1. Selected new diagnostic phytoliths. See MU Phytolith website (http://www.missouri.edu/~phyto) for photographs of all types. g, h. 160X Manihot (Euphorbiaceae) secretory cell

Manihot sp.

Phytolith

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (http://www.missouri.edu/~phyto) for other photographs e. 160I Manihot secretory cell, PS1804FS 3294-B. f. 160I Manihot secretory cell, PS1804FS 3294-B. g. 160I Manihot secretory cell, PS3, Structure 20 floor sediment. h. 160I Manihot secretory cell, PS1804FS3294-B.

FABACEAE
Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. c, Fabaceae starch with central depression (“cd”), c1, the same starch reflecting damaging signs at the center as noted by the extinction cross; d, Fabaceae starch in lateral (eccentric) view with a longitudinal fissure (“lf”); d1, the same starch projecting the extinction cross.
Acacia macrocantha

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: family, seeds/pods

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
**Acacia visco**

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pod</strong></td>
</tr>
<tr>
<td>no diagnostic phytoliths (*)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Starch assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, oval to spherical; variable in size, from 18μm to 25μm long length; not visible hilum and lamella; a centric hollow with a similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at a dark oval or circular hollow.</td>
</tr>
<tr>
<td>b) Compound grains, with a single external package elongated, variable in shape, size, and number of granula. Granula: uncertain shaped; ca. 10μm; not-visible hilum and lamella; distinct centric cross, with four arms visible, intersecting at a line or a dark center.</td>
</tr>
</tbody>
</table>

Scale bar = 20μm.

---

Korstanje and Babot, 
McCown Archaeobotany 
Laboratory Collection
Anadenanthera colubrina

Korstanje and Babot,
McCown Archaeobotany Laboratory Collection
Figure 6. Modern starch grains from Anadenanthera peregrina. Starch grain from mature seeds and starch grain cluster showing shapes, dimensions, and types of fissures that are common in A. peregrina. AFS = asymmetrical fissures and striations; RFS = radial fissure and striations; TF = transversal fissure; YF = “Y” shaped fissure. Note: oval starch grain at the extreme right; transovate-obtuse starch grain at the extreme left. Scale for all microphotographs: space between major units (numbers) = 37.5 µm.

Anadenanthera peregrina

Starch

Figure 7. Starch grains recovered from the coral milling base from CE-11: (a) starch grain cluster from cojoba or A. peregrina (to the right is the same cluster cross-polarized in dark field); (b) oval starch grain with a transversal fissure (the same cross-polarized); (c) transovate-obtuse starch grain with thin striations and radial fissure that are typical of A. peregrina (the same cross-polarized); (d) oval starch grain (the same cross-polarized); (e) and (f) broken starch grains, probably broken by the grinding process. TF = transversal fissure; RFS = radial fissure and striations. Scale for all microphotographs: space between major units (numbers) = 37.5 µm

Anadenanthera peregrina

Starch

Figure 8. Modified and/or damaged starch grains from modern Anadenanthera peregrina (cojoba) seeds after parching (toasting). All the starches lost their extinction crosses, some of them (b) quadrupled their size due to the gelatinization process, and others (c) revealed a small circumscribed central depression (“scoop”). Scale for all microphotographs: space between major units (numbers) = 37.5 µm.

**Arachis hypogaea**

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
</table>
| **Pod and seed.** Non diagnostic phytoliths (*):
  a) Polyhedral calcium oxalate phytolith. Common. |

<table>
<thead>
<tr>
<th>Starch assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, spherical and subspherical; variable in size, from 4μm to 10μm long length; distinct centric hilum as clear spot with a round cavity; distinct fine lamella; generally an elongated central cleft with short radiating fissures extends the length of the grain; distinct centric cross, with four arms visible, intersecting at a dark oval or line.</td>
</tr>
<tr>
<td>b) Some compound grains, without a single external package, compounded by two granula. Granula similar in size and shape; bowl-shaped with wavy truncation; ca. 7μm long length; distinct eccentric cross, to the truncate end, with four arms visible.</td>
</tr>
</tbody>
</table>

Arachis hypogaea

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Arachis hypogaea

Starch

Starch grains from modern peanuts. 160x

APPENDIX:
Arachis hypogaea (peanut) (Figure 7). Simple grains with fine laminations. The hilum appears as a clear spot with a round cavity. An elongated central cleft with short radiating fissures extends the length of the grain. Size: 4–10 microns long

Brownea grandiceps

Phytolith

probably calcium carbonate (CaCO3) crystals.
Appeared in many of the genera of the Fabaceae, but also present in Musaceae, Flacourtiaceae and Bombacaceae.
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Brownea ucayalina

Phytolith

From the top, this hair base may be confused with a diagnostic produced by Dalium guianense (also of the Fabaceae family). Rotate to see the thickness of the hair base. Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Brownea ucayalina

Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Brownea ucayalina

Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meaghan O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Canavalia spp.

Starch

Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. b, Canavalia spp. oval starch showing partial lamellae (“L”); b1, the same starch with extinction cross

Canavalia rosea

Starch

Cicer arietinum

Starch

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Cicer arietinum

Starch

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Dalium guianense

Phytolith

Slide 1766e leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Dalium guianense

Phytolith

Slide 1766e leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Dalium guianense

Phytolith

Slide 1766e leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Dalium guianense

Phytolith

Ornamental Indigo. From the top, this may be confused with Brownea ucyalina, rotate to see the thickness of the hair base. Slide 1766e leaf. Typed defined by Shawn Collins 01/1999.

Diagnostic level: genus Description

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Enterolobium cyclocarpum

Starch

APPENDIX:
Enterolobium cyclocarpum. Simple grains, very irregular in shape, with a rough surface. When turned to the side a long fissure can be seen.

Erythrina amazonica

Phytolith

Slide 1811. Leaf.
Diagnostic level: mixed Guazuma, Erythrina, Lithospermum

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
## Geoffroea decorticans

### Archaeobotany Laboratory Collection

#### Leguminosae Geoffroea decorticans “chañar”

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
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<tr>
<td><strong>Endocarp and seed</strong></td>
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<tr>
<td>Non diagnostic phytoliths (1):</td>
</tr>
<tr>
<td>a) Semi-spherical facetate silica phytolith. Rare.</td>
</tr>
<tr>
<td>b) Sub-round silica phytolith. Rare.</td>
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<th>Fruit</th>
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<td><strong>Endocarp.</strong></td>
</tr>
<tr>
<td>a) Compound grains, with a polyhedral package five- to six-sided; variable in size, to 60µm long length, compounded by at least 24-26 granula different in size. Granula range in size from 3µm to 9µm; very distinct centric hilum as a circle; not visible lamella; distinct centric cross, with four arms visible.</td>
</tr>
<tr>
<td><img src="image2.jpg" alt="Image" /></td>
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<table>
<thead>
<tr>
<th>Pulp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, spherical; to 6µm long length; not visible hilum and lamella; distinct centric cross, with four arms visible.</td>
</tr>
<tr>
<td><img src="image4.jpg" alt="Image" /></td>
</tr>
</tbody>
</table>

Scale bar = 20µm.
Inga densiflora

Phytolith

Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Inga densiflora

Phytolith

Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Inga densiflora

Phytolith

Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Inga densiflora

Phytolith

Side view. See Record #187 for top view.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Inga densiflora

Phytolith

Top - 3/4 view.

See side view (Record #186) to see two layers of surrounding cells. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Inga spectabilis

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Inga spectabilis

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: undetermined

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Lablab purpureus

Starch

Lens culinaris

Starch

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes we re popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

### Lupinus mutabilis

**Leguminosae** *Lupinus mutabilis* “tarwi”

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non diagnostic phytoliths (*):</td>
<td>b) Irregular calcium oxalate</td>
</tr>
<tr>
<td>a) Irregular silica phytolith. Rare.</td>
<td>phytoliths. Common.</td>
</tr>
<tr>
<td></td>
<td>No phytoliths (*).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seed</th>
<th>Pod</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="#">Image 1</a></td>
<td><a href="#">Image 2</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Starch assemblage characterization</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, spherical to oval,</td>
<td></td>
</tr>
<tr>
<td>well rounded; variable in size from</td>
<td></td>
</tr>
<tr>
<td>8µm to 40µm long length; indistinct</td>
<td></td>
</tr>
<tr>
<td>centric hilum; not-visible lamella;</td>
<td></td>
</tr>
<tr>
<td>sometimes irregular radiating or</td>
<td></td>
</tr>
<tr>
<td>regular line fissures and a hollow</td>
<td></td>
</tr>
<tr>
<td>at the center; distinct, centric or</td>
<td></td>
</tr>
<tr>
<td>lightly eccentric cross, with four</td>
<td></td>
</tr>
<tr>
<td>arms visible; distinct border.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="#">Image 3</a></td>
<td><a href="#">Image 4</a> <a href="#">Image 5</a> <a href="#">Image 6</a></td>
</tr>
</tbody>
</table>

Scale bar = 20µm.
Macroptilium lathyroides

Starch

# Pachyrhizus ahipa

**Leguminosae Pachyrizus ahipa “ajipa”**

## Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>Tubercle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No phytoliths (*)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leaves</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>d) Irregular castellate silica phytolith.</td>
<td></td>
</tr>
<tr>
<td>f) Continuous crenate silica phytolith. Rare.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tubercle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non diagnostic phytoliths (*):</td>
<td></td>
</tr>
<tr>
<td>a) Acicular silica hair. Common.</td>
<td></td>
</tr>
<tr>
<td>b) Roundel asymmetrical cavated silica phytolith. Common.</td>
<td></td>
</tr>
<tr>
<td>c) Semi-roundel gibbous silica phytolith. Rare.</td>
<td></td>
</tr>
</tbody>
</table>

Scale bar = 20μm.
Pachyrhizus erosus

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: root/tuber

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Phaseolus lunatus

<table>
<thead>
<tr>
<th>Pod</th>
<th>Non diagnostic phytoliths:</th>
<th>Leaf</th>
<th>Seed stem</th>
<th>Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b) Polyhedral opaque silica hair base. Very common.</td>
<td>b) Acicular translucent silica hair cells. Very common.</td>
<td>b) idem and Sinuate silica epidermal cells. Very common.</td>
<td>No phytoliths.</td>
</tr>
<tr>
<td></td>
<td>c) Polyhedral irregular silica phytolith. Rare.</td>
<td>c) Irregular translucent silica hair cells. Very common.</td>
<td>c) Silica frached. Common.</td>
<td>Starch assemblage characterization</td>
</tr>
</tbody>
</table>

| References: Reported in Bozarth 1986 (4) We have found no hooked silicified hairs in the pods but in the leaves. |
| References: Reported in Bozarth 1986 for the pods. |

Scale bar = 20µm.

Korstanje and Babot,
McCown Archaeobotany Laboratory Collection
Phaseolus lunatus

Phytolith

Phaseolus hair, small when compared to 40IIIAa301. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Phaseolus lunatus

Phytolith

Phaseolus hair, small when compared to 40IICa301.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
## Phaseolus vulgaris

**Leguminosae Phaseolus vulgaris - var. vulgaris “poroto”**

### Phytolith assemblage characterization

#### Seed

**References:** Reported in Bozarth 1990

### Starch assemblage characterization

#### Seed

- a) Single grains, oval, ovoid, spherical, kidney-shaped, irregularly lobed, polyhedral, ellipsoidal, irregular; variable in size from 2μm to more than 60μm long length; distinct centric hilum, elongated; distinct lamella; a ragged mesial fissure, and radiating lines from the hilum; distinct centric cross, with four irregular arms visible, intersecting at a central ragged line or dot, or meeting two by two.

#### Seed

- b) Compound grains, compounded by two or more granula with a single external package. Granula variably in shape, size and orientation; same type of simple ones, distinct centric cross, with visible arms intersecting at different points.

#### Seed

- c) Compound grains, with a fiber-like or polyhedral package; variable in size, to 60μm long length, compounded by granula different in size. Granula range in size from 3μm to 5μm; very distinct centric hilum circle-, v- or x-shaped; not visible lamella; distinct centric cross, with four arms visible.

**References:** Partially based on Piperno and Holst 1998, Reichert 1913, Yañez et al. 1997

Scale bar = 20μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Phaseolus vulgaris

Phytolith

Figure 5. Phytoliths from leaves of common bean Phaseolus vulgaris L.; a) 92.4µm, 12.26µm; b) 78.2µm, 9µm; c) 88.64µm, 10.32µm; d) 102.96µm, 9.94µm; e) 57.37µm, 8.51µm; f) 93.5µm, 11.9µm. Scale: 10 µm by 40X

Phaseolus vulgaris

Phytolith

Phaseolus hair, small when compared to 40IIIAa301.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Phaseolus vulgaris

Phytolith

Phaseolus hair, small when compared to 40IIIAa301.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Phaseolus vulgaris

Phaseolus vulgaris

Starch

Phaseolus vulgaris

Starch

Starch grains from modern Phaseolus vulgaris beans. 160x

APPENDIX:
Phaseolus vulgaris (common bean) (Figure 6). Simple grains, oval and laminated, with a large, ragged mesial fissure that extends the length of the grain. Size: 14–6 microns long.

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Pithecolobium latifolium

Phytolith

2. Silicified sclereids from Pithecolobium latifolium (250x).
3. Silicified sclereids from Pithecolobium latifolium (250x).

# Prosopis nigra et alba

## Leguminoseae *Prosopis nigra et alba* “algarobo”

### Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>Pod and seed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non diagnostic phytoliths:</td>
</tr>
<tr>
<td>a) Round dorsal irregular faceted silica phytolith. Rare.</td>
</tr>
<tr>
<td>b) Round psilate silica phytolith. Rare.</td>
</tr>
<tr>
<td>c) Polyhedral calcium oxalate phytolith.</td>
</tr>
</tbody>
</table>

### Starch assemblage characterization

<table>
<thead>
<tr>
<th>Pod</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, variable in shape, oval and spherical, elongated; variable in size, to 80μm long length; sometimes distinct hilum as a line or circle; not visible lamella; a circular, oval or elliptical hollow at the center with a similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at dark oval or circular hollow.</td>
</tr>
<tr>
<td>b) Also common spherical grains; distinct centric cross, with four arms visible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, variable in shape, oval, spherical; variable in size, from 5μm to 30μm long length; sometimes distinct centric hilum as a line or circle; not visible lamella; a circular, oval or elliptical hollow at the center with a similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at a dark oval or circular hollow. May occur in bunch aggregates.</td>
</tr>
<tr>
<td>b) Also common spherical grains, distinct cross, with four arms visible, intersecting at a vertical line or circle.</td>
</tr>
</tbody>
</table>


Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Vigna radiata

Starch

Fig. 1. Comparisons of raw and boiled starch grains showing damage to extinction crosses. (b) Mung bean starch grains. Left side, raw mung bean starch grains; right side, mung bean starch grains boiled for 10 min. Once again the cross is faded around the outside and less distinct, though there is very little change visible under regular light. Each image is 50 mm wide.

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Vigna radiata

Starch

![Starch grain types](image)

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

FAGACEAE
Lithocarpus acuminatissima

Fig. 3. (a) Facetate phytoliths from Asian Fagaceae (Lithocarpus acuminatissima), left, and Annonaceae (Goniothalamus marcani), right. Reprinted from Kealhofer and Piperno, 1998. Reprinted from Piperno (2006a), Copyright AltaMira Press.

FLACOURTIACEAE
Caesaria sylvestris

Phytolith

See Record #140 for a variation of the same body. Occurs in the leaf. Small, tall hair cell base. Note the decorated schlerids in background--these are common in the sample. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Caesaria sylvestris

Phytolith

Side view (see also Record #139); tall hair base, small. Occurs in the leaf. Note the decorated sclerids in background--these are common in the sample. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Caesaria sylvestris

Phytolith

Stomate with two subsidiary cells.
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Caesaria sylvestris

Phytolith

Top view. See Records #140,139 for a variation of the same body. Occurs in the leaf. Small, tall hair cell base. Note the decorated schlerids in background--these are common in the sample. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pleurananthodendron lindenii

Phytolith

Occurs in the leaf. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pleuranthodendron lindenii

Phytolith

Occurs in the leaf. In this example, the surrounding disk is not completely developed.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pleuranthodendron lindenii

Phytolith

Slide 1377 leaf.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
**Pueraria phaseoloides**

**Phytolith**

Moderate to common in abundance.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Tetrathylacium macrophyllum

Phytolith

Occurs in the leaf. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
HAEMODORACEAE
Conostylis bracteata

Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. E. Conostylis bracteata (Haemodoraceae), large quantities of silica sand in vascular bundle-sheath cells (bar = 10 µm).

Anigozanthos flavida

Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. F. Anigozanthos flavida (Haemodoraceae) epidermal cells containing silica sand (bar = 10 µm)

HELICONIACEAE
Heliconiaceae

Phytolith

g. Morphotype with trough diagnostic of the wild plantain family (Heliconiaceae).

2. Silica bodies with troughs from Heliconia (250 x). Also present are spherical rugulose phytoliths and two narrowly oblong sinuate phytoliths.

Fig. 3. Phytoliths from San Andre´s. (d) A burned Heliconia phytolith from 1,115 cm

Heliconia sp.

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. p) Decorated Heliconia body with troughs (K-VIIIIM3.1, 0e10 cm)

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). M, T1 psilate trough from Heliconia sp. rhizome. N, T1 papillate trough from Heliconia sp. rhizome. O, T3 trough (fused globulars) from Heliconia sp. rhizome. Scale bars: A–J, M–Z = 12 µm; K, L = 5 µm


Heliconia curtispatha

Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Heliconia curtispatha

Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Heliconia curtispatha

Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Heliconia curtispatha

Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Heliconia lathispatha

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). S, subglobular-granulate from Heliconia librata fruit. Scale bars: A–J, M–Z=12 µm; K, L=5 µm

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). K, Ta3 (tabular-granulate) from Heliconia pendula leaf. L, thickened Ta3 from Heliconia pendula leaf. Scale bars: A–J, M–Z=12 µm; K, L=5 µm

Heliconia psittacorum

Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. C. Heliconia psittacorum (Heliconiaceae), trough-shaped silica bodies over vascular bundle-sheath fibers (bar = 20 µm).

Heliconia psittacorum

Fig. 3. Phytoliths from non-grass monocots. 1) Troughed bodies from Heliconia psittacorum

Heliconia aff. tortuosa

Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. D. Heliconia aff. Tortuosa (Heliconiaceae), trough-shaped silica bodies with silica fingers projecting from the base into the cell wall (bar = 10 µm).

Heliconia velutina

HERNANDIACEAE
Humiriastrum procerum

Phytolith

Occurs in leaf. Type defined by Cesar Vientimilla 05/1991. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Fig. 2. Phytoliths with little or no taxonomic value. a) Polyhedral epidermis from *Humiriastrium subcrenatum*

HYMENOPHYLLACEAE
Trichomanes hostmannium

Fig. 6. Phytoliths from Pteridophytes. e) Bowl-shaped phytoliths from Trichomanes hostmannium

JUGLANDACEAE
**Juglans australis**

### Phytolith assemblage characterization

**Endocarp and seed embryo.**

- **a)** Bilobate (saddle) central depressed silica phytolith. Rare.
- **b)** Rectangular irregular central depressed silica phytolith. Rare.
- **c)** Tri-lobate irregular silica phytolith. Rare.
- **d)** Rectangular dorsal echinate silica long cell. Rare.

### Starch assemblage characterization

**Endocarp and seed embryo.**

- **a)** Single grains, variable in shape, oval, spherical, pear-shaped and irregular; variable in size, commonly from 9μm to 17μm, some to 45μm long length; not visible hilum and lamella; a centric hollow with similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at a dark circular hollow.
- **b)** Some compound grains, compounded by two subspherical granula. Granula shorter than single ones.

*References:* Reported as not common epidermis, hair bases, mesophyl in Piperno 1980, 35 for *Juglans nigra* leaf (quoting Geis 1972).

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**Korstanje and Babot, McCown Archaeobotany Laboratory Collection**
JUNCACEAE
Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. D. Juncus arabicus (Juncaceae), silica sand in vascular bundle-sheath cells (bar = 10µm).

Juncus inflexus

Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. C. Juncus inflexus (Juncaceae), silica sand in bundle-sheath cells (bar = 20 µm).

LAURACEAE
Aniba hostmanniana

Phytolith

2 large examples of schlerids, note variation in facets, shape. This taxa produces very sculpted, multi-surfaced bodies. Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Aniba hostmanniana

Phytolith

2 large examples of schlerids, note variation in facets, shape.
This taxa produces very sculpted, multi-surfaced bodies.
Diagnostic level: generalized arboreal
Aniba hostmanniana

Phytolith

Stomate, note guard cells and turgid state of cells.
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Aniba hostmanniana

Phytolith

Hair base.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Beilschmiedia alloiophylla

Phytolith

Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Caryodaphnopsis fosteri

Phytolith

Side view (see Record #193 for top view).
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Caryodaphnopsis fosteri

Phytolith

Top view (see Record #192 for side view).
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Chlorocardium venenosum

Phytolith

Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Chlorocardium venenosum

Phytolith

Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Nectandra globosa

Phytolith

Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
LORANTHACEAE
Phrygilanthus corymbosus

Phytolith

2. Irregular, unpointed chunks of silica from Phrygilanthus corymbosus (200 ×)

Phthirusa pyrifolia

Phytolith

4. An irregular, pointed phytolith from Phthirusa pyrifolia (250 x)

Orchidantha sp.

Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. E. Orchidantha sp. (Lowiaceae), truncated conical silica bodies overlying a vascular bundle (bar =10 µm).

Orchidantha chinensis

Phytolith

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). X, hat-shape with knobby edges from Orchidantha chinensis leaf. Scale bars: A–J, M–Z=12 µm; K, L=5 µm

Orchidantha longiflora

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). W, side-view of hat-shape with knobby edges from Orchidantha longiflora leaf. Scale bars: A–J, M–Z = 12 µm; K, L = 5 µm

Orchidantha siamensis

Phytolith

Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). Y, hat-shape with crenate edges from Orchidantha siamensis leaf. Z, Ta3 (tabular-granulate) from Orchidantha siamensis leaf. Scale bars: A–J, M–Z = 12 µm; K, L = 5 µm.

LYGODIACEAE
Lygodium cirunntum

Australian Museum, McCown Archaeobotany Laboratory Collection
Lygodium circinnatum

Australian Museum, McCown Archaeobotany Laboratory Collection
Magnolia sp.

Phytolith

Fig. 2. Center, a genus-specific phytolith from the leaves of Magnolia from (Magnoliaceae) Late Pleistocene-age lake sediment from Panama. Palynologists are unable to distinguish the pollen of the closely related taxa Talauma and Magnolia.

Talauma sp.

Phytolith

Fig. 1. Center, a genus-specific phytolith from the leaves of Talauma (Magnoliaceae) from modern soils underneath tropical montane forest in Panama.

MALVACEAE
Gossypium sp.

Phytolith

Compare to 160I, small heart-shaped secretory body. 160II has a variably shaped center. Observed in Gossypium (PC 2665); diagnostic level under study.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Gossypium sp.

Phytolith

Compare to 160I, small heart-shaped secretory body. 160II has a variably shaped center. Observed in Gossypium (PC 2665); diagnostic level under study.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Gossypium sp.

Phytolith

In PC E1022, Gossypium. Also observed in PC E1004, Malachra alceifolia, Malvaceae
Diagnostic level: Malvaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Gossypium sp.

Phytolith

PC E1022. This image shows hair base cells, a spherical cystolith of loose structure.
Diagnostic level: Malvaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Gossypium sp.

Phytolith

See size variation in cystoliths.
Diagnostic level: generalized arboreal
Note that this type formed the base of hair 40IIIIBb

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Gossypium barbadense

Phytolith

4. Silicified mesophyll cells from Gossypium barbadense (250 x).

Hibiscus manihot

Australian Museum, McCown Archaeobotany Laboratory Collection
Hibiscus manihot

Malvaceae
Hibiscus manihot
stem
No. 4
×1000

Malvaceae
Hibiscus manihot
stem
No. 4
×600

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Malaviscus arboreus

Phytolith

1. Threadlike hairs from Malaviscus arboreus (156 × ).

Theobroma cacao

Phytolith

1. A silicified tracheid from Theobroma cacao (250 × ).

MARANTACEAE
Marantaceae

Phytolith

Morphotype diagnostic of the Marantaceae, and likely derived from the seed of arrowroot (*Maranta arundinacea* L.)

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. o) Marantaceae sphere (BD M1, 20-30 cm). q) Marantaceae seed phytoliths (P Ridged Field 2, 10-20 cm).

Fig. 5. Selected microbotanical remains. Phytoliths: o) Marantaceae 1 seed (Sed. Sample 4), p) Marantaceae 2 seed (Sed. Sample 3)

Ataenidia conferta

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). W, rugose hat-shape with sinulate margins from Ataenidia conferta leaf. X, D1 fringed druse from Ataenidia conferta leaf. Scale bars=12 μm.

Calathea/Maranta

Phytolith

Fig. 1. Selected new diagnostic phytoliths. See MU Phytolith website (http://www.missouri.edu/~phyto) for photographs of all types. a. 26Ia Calathea (Marantaceae) irregular rhizome cylinder. b, c. 26Ia Calathea (Marantaceae) flat domed rhizome cylinder. d. 26Ib Maranta/Calathea (Marantaceae) rhizome spindle. e, f. 26Iib Calathea (Marantaceae) flat rhizome type.

Calathea sp.

Phytolith

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (http://www.missouri.edu/~phyto) for other photographs. a. 26Ia Calathea irregular rhizome cylinder, PS1749 FS 3290-A. b. 26Ib Calathea flat domed rhizome cylinder, PS1749 FS 3290-A. c. 26Ib Calathea flat domed rhizome cylinder, PS1765 FS 3293-B. d. 26IIb Calathea flat rhizome type, PS1804 FS3294-B.

Calathea allouia

Phytolith

Fig. 8. Seed phytolith from lleren. It is 40 mM long. From Piperno, 2006.

Calathea allouia

Phytolith

Fig. 18. Phytoliths from the seeds of Calathea allouia (leren). They are diagnostic because they have flat and undecorated upper bodies, in contrast to all other studied species in the Marantaceae.

Calathea allouia

Phytolith

Fig. 12. Center, a phytolith from the rhizome of Calathea allouia recovered from a preceramic level of Vegas Site 80. The phytolith assemblage of which it was a part was directly dated to 93207250 B.P. The phytolith is 30mm long.

Calathea allouia

Phytolith

Body on left is 22VIIbC2 (no spikes).
Body on right is 22VIIbC3 (spikes).
Diagnostic level: species (both types)

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

“Top” or dome-side view of “tip only” from Calathea allouia. You can only identify to species if you can match dome and spines. Otherwise identify only to Genus. Inset shows closeup of underside of C. allouia “tip only” where shaft of cylinder has broken away.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Diagnostic level: species Note that the “tip only” and pieces of cylinder only are also visible in this image (bottom view of “tip only” in bottom right side of field, piece of cylinder only in center left side of field). Inset shows closeup of C.allouia type... Notice the distinctive traits of the thin spines surrounding a flattened dome tip.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

The phytolith to the left of the scale shows the tip clearly.
Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea rhizomes

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea rhizomes

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolíth

Phytolíthos above the scale are this type. Phytolíth at lower right is 261Aa (see record 258)
Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea genus, rhizome

See phytolíth at lower right. The other forms are 261IB
Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea, rhizome

Pearsall, Deborah Marie. "Phytolíths in the Flora of Ecuador: The University of Missouri Online Phytolíth Database." [http://phytolíth.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea, rhizome

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea, rhizome

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea, rhizome

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea genus, rhizome

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Calathea genus, rhizome

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2458
Diagnostic level: Potential species-level diagnostic. Type overlaps with 80lKa, but is distinguished by size. Occurs in leaf and less often in inflorescence

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2458
Diagnostic level: Potential species-level diagnostic. Type overlaps with 80IKa, but is distinguished by size. Occurs in leaf and less often in inflorescence.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2596 Calathea allouia leaf These folded/angled spheres have distinctive nodules separate from the folds. Grade into rugulose (bumpy, rough surface) spheres. Type first defined by Karol Chandler-Ezell Diagnostic level under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2596 Calathea allouia leaf These folded/angled spheres have distinctive nodules separate from the folds. Grade into rugulose (bumpy, rough surface) spheres. Diagnostic level under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2597 Calathea allouia stem some examples are curved, but not hemispherical
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2597 Calathea allouia stem some examples are curved, but not hemispherical
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2598, inflorescence
Note that this type can be quite long;
considerable variation is present
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2598, inflorescence
Note that these inflorescence types can be quite large; size is variable
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea alouia

Phytolith

PC2598, inflorescence
Note that these inflorescence types can be quite large; size is variable
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
**Calathea allouia**

**Phytolith**

PC2598, inflorescence, type occurs rarely.
Spheres produced by Canna range from smooth to rugulose to irregularly angled or folded. Type 80IAa201 is based on a modern specimen of Canna edulis leaf. Ephemeral spherical bodies are not included in this type. Diagnostic level: Canna genus (rare in Calathea)

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Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

PC2598, inflorescence Nodular spheres moderate in occurrence, variable in size and height of projections. This is a large example (80ICa2); smaller also present (80ICa1)

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

type established by Karol Chandler-Ezell
PC2348, C. allouia inflorescence
Diagnostic level: Calathea/Maranta

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Phytolith

type established by Karol Chandler-Ezell
PC2348, C. allouia inflorescence
Diagnostic level: Calathea/Maranta

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea allouia

Starch

Calathea altissima

Phytolith

Calathea spp. seed body. Still has distinct, curved stalk tip of Calathea spp., but cylinder is very short relative to width. Diagnostic level: genus.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea altissima

Phytolith

seed body. Still has distinct, curved stalk tip of Calathea spp., but cylinder is very short relative to width. note “corkskew” axis of main body shaft. This appears to be a point where the bodies “break” resulting in Tip pieces and base pieces. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea altissima

Phytolith

“underside” of seed bodies, Note flattened, polygonal edges, finely rugulate/granular underside Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea crotalifera

Phytolith

Note the 80IIIB rugulose conical bodies in background....
Especially note bulbous rims of seed body tips.
Diagnostic level: family, wild taxa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea crotalifera

Phytolith

seed bodies, background has rugulose conical bodies
Diagnostic level: family, wild taxa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea crotalifera

Phytolith

Marantaceae nodular spheres and rugulose conical bodies Diagnostic level: Marantaceae/Bombacaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea lutea

Phytolith

Marantaceae conical body Top view.
Type is centered above the 25.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea lutea

Phytolith

Length is 27.5 microns leaf sample.
Body occurs to the right of the 80IIIB example.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea lutea

Phytolith

PC2594, floret
These are large examples of the type,
VA
Diagnostic level: Calathea/Maranta

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
**Calathea lutea**

**Phytolith**

PC2594, floret

These are large examples of the type,

VA

Diagnostic level: Calathea/Maranta

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea lutea

Phytolith

PC2595, leaf
This photo shows a string of the bodies
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea lutea

Phytolith

PC2595, leaf, abundant
Epidermis fragment showing anticlinal cells (20IA), stomata (120), and schlerids (110).
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea macrosepalapa

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). A, rugose hat-shapes from Calathea macrosepalapa leaf. B, subglobular-papillate from Calathea macrosepalapa leaf. C, D1 fringed druse from Calathea macrosepalapa stem. F, globular-densely granulate with non-centered concavity from Calathea macrosepalapa seed. L, cylindrical-densely granulate with non-centered concavity from Calathea macrosepalapa seed. Scale bars=12 μm.

Calathea macrosipalia

Phytolith

Length is 27.5 microns leaf specimen
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea majestica

Phytolith

PC1385a, fruit, very abundant seed body, still has distinct, curved stalk tip of Calathea spp., but cylinder is very short relative to width. Note “corkskrew” axis of main body shaft. This appears to be a point where the bodies “break” resulting in Tip pieces and base pieces. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea majestica

Phytolith

PC1385a, fruit, very abundant seed body, still has distinct, curved stalk tip of Calathea spp., but cylinder is very short relative to width. note “corkskrew” axis of main body shaft. This appears to be a point where the bodies “break” resulting in Tip pieces and base pieces. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea majestica

Phytolith

PC1385a, fruit, very abundant seed body, still has distinct, curved stalk tip of Calathea spp., but cylinder is very short relative to width. Note “corkskew” axis of main body shaft. This appears to be a point where the bodies “break” resulting in Tip pieces and base pieces. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea majestica

Phytolith

PC1385a fruit
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea majestica

Phytolith

PC1385 fruit, rare. Also observed in Donax, Maranta specimens
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea marantina

Phytolith

Wild Marantaceae seed body.
Diagnostic level: family, wild taxa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea marantina

Phytolith

seed body
Diagnostic level: family, wild taxa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea marantina

Phytolith

seed body.
Note variation in width of cylinder, Stalk on tip of body on left is very small, reduced.
Stalk is missing on body on the left.
Diagnostic level: family, not Maranta

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Calathea micans

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). E, globular-rugulate from Calathea micans rhizome+root. Scale bars=12 μm.

Calathea veitchiana

Starch

Calathea violacea

Phytolith

SEM photograph of a phytolith with an irregularly angled or folded surface from Calathea violacea (4000x).

Calathea violacea

Phytolith

2. Center, a hat-shaped nodular silica body from Calathea violacea (400 x ).

Calathea zebrina

Starch

Calathea zebrina

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). D, elongate D1 fringed druse from Calathea zebrina rhizome. Scale bars=12 μm.

Calathea sp.

A cf. Calathea starch grain from La Mula. 160x. The grain measures 50 microns by 16 microns.

Calathea sp.

Starch

Fig. 2. Selected archaeological starch grains. (E) Calathea sp. starch from Casita de Piedra, edge-battered cobble 69/2, 3600 cal BP. (Scale bar: 10 µm.) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.

Donax sp.

Phytolith

PC1387, leaf, common
Epidermis fragment showing anticlinal cells
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax sp.

Phytolith

PC1388 fruit, very abundant Diagnostic level: Donax

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
PC1388 fruit, very abundant Diagnostic level: Donax
Donax sp.

Phytolith

PC1388 fruit, very abundant Diagnostic level: Donax
This image shows the base of the head, within the cylinder (from beneath)
Donax sp.

Phytolith

PC1388 fruit, very abundant Diagnostic level: Donax
This image shows the top of the head, extending out from the cylinder

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax sp.

Phytolith

PC1388 fruit Moderate
Diagnostic level under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax sp.

Phytolith

PC1388 fruit Moderate
Diagnostic level under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
Can look like a very large conical body
Diagnostic to genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280 inflorescence Type first defined in Costus.
Side view of conical form. Sometimes the projections break off, leaving flat rugulose/nodular bodies
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280 inflorescence, common
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280 inflorescence
Diagnostic level under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280 inflorescence Diagnostic level under study
Body below scale bar is conical (80IIIB) viewed from top

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280 inflorescence
Diagnostic level under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
Note variation in size, shown in following records.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
Note variation in size, shown in following records.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
Note variation in size, shown in following records.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastraum

Phytolith

PC280, inflorescence
Note variation in size, shown in following records.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
May look like a large conical body
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
Diagnostic level: Marantaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
When very broad are difficult to roll and appear in bottom view, as seen here
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax arundastrum

Phytolith

PC280, inflorescence
When very broad are difficult to roll and appear in bottom view, as seen here
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Donax cannaeformis

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Donax grandis

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). I, tabular-jigsaw from Donax grandis leaf. J, rugose hat-shape from Donax grandis leaf. K, stomatal complex from Donax grandis leaf. Scale bars=12 μm.
Ichnosiphon arouma

Fig. 3. Phytoliths from non-grass monocots. m) Irregularly angled/folded bodies from Ichnosiphon arouma, n) Nodular sphere from I. arouma, o) Conical body from I. arouma

Ischnosiphon inflatus

Phytolith

seed bodies.
Show range of variation in wild types.
Diagnostic level: Marantaceae, wild taxa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Ischnosiphon inflatus

Phytolith

Seed bodies. Note how body continues to narrow below tip.
Diagnostic level: family, wild taxa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Ischnosiphon inflatus

Phytolith

Spiralling of “corkscrew” along shaft very apparent in body right of center. Diagnostic level: family, wild taxa

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. b: Starch granule of Maranta sp. recovered from flake 2.
Maranta arundinacea

Fig. 7. Seed phytoliths from arrowroot. From Piperno, 2006.

Maranta arundinacea

Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. F. Maranta arundinacea (Marantaceae), costal silica bodies in mesophyll cells (bar = 10 µm).

Maranta arundinacea

Phytolith


Maranta arundinacea

Phytolith

Note both conical (hat-shaped) bodies and nodular spheres in this field. Both appear in Marantaceae. 80IIIB looks like rugulose or nodular sphere in flat view, but side view shows conical shape.
Diagnostic level, 80IIIB: family
Diagnostic level, 80ICA1:
Marantaceae/Bombacaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

Note the “bottom” view of the bodies, since this is the typical side up. Often it looks like an irregular star- shape or a granular textured disk with irregular margins.
Note in bottom left and far right “tip” only bodies. see below.
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

Note how much shorter in length cylinders are compared to Maranta spp. type -- yet “tips” are larger.
Compare to other photos of this type for variation.
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

Note shortness of cylinder compared to "tip" and Maranta sp. type.
Diagnostic level; species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

Type established by Karol Chandler-Ezell, 2004
Diagnostic level: Maranta/Calathea rhizomes

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2670, fleshy rhizome, moderate
A seed body type,
Diagnostic level: family, wild taxa;
occurs in one specimen of arrowroot rhizome

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
**Maranta arundinacea**

**Phytolith**

PC2670, fleshy rhizome, moderate
A seed body type,
Diagnostic level: family, wild taxa;
occurs in one specimen of arrowroot rhizome

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Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2670, fleshy rhizome, moderate A seed body type,
Diagnostic level: family, wild taxa;
occurs in one specimen of arrowroot rhizome

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2038, inflorescence
Diagnostic level: species
This image is a view from the bottom
(often in this rotation)

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2038, inflorescence
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2038, inflorescence
Diagnostic level: species
View from the bottom

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2038, inflorescence
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2038, inflorescence
Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

PC2038, inflorescence
Diagnostic level: species
View is of partially rotated body

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta arundinacea

Phytolith

1. SEM photograph of spherical, nodular phytoliths from Maranta arundinacea (3000x).
2. Spherical, rugulose phytoliths from Maranta arundinacea (200x).

Maranta arundinacea

Phytolith

1. Center, two rows of hat-shaped phytoliths from Maranta arundinacea (200×).

Maranta arundinacea

Starch

Starch grains from a modern tuber of arrowroot. 80x

APPENDIX:
Maranta arundinacea (arrowroot) (Figure 5). Simple, oval grains, with one or two indentations, laminated. The hilum is eccentric and often has one fissure or a y fissure placed on the proximal edge of the grain. Size: 10–50 microns long

Maranta arundinacea

Starch

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (http://www.missouri.edu/~phyto) for other photographs. k. Maranta arundinacea starch granule, SS42 FS3294-B

Fig. 2. Selected archaeological starch grains. (A) Arrowroot (Maranta arundinacea) starch from Casita de Piedra, flakeknife 101/15, 77400 cal BP. (Scale bar: 10 µm) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.
Maranta gibba

Phytolith

Large (10-30 microns) rugulose spheres. Rugulose spheres occur in many taxa, very common in Marantaceae, Bombacaceae, Cannaceae, Heliconiaceae, and Chrysobalanaceae. Small rugulose spheres (< 10 microns) that are well silicified (i.e., opaque) are, according to Iriarte and Piperno, characteristic of woody dicots. Large spheres (10-30

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

Maranta spp. inflorescence body,
Diameter of central cylinder is
37 microns wide
Note: may occur in all Maranta spp.,
including Maranta arundinacea
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

Small, “incomplete” seed body. Note absence of “tip” or “stalk” typical of the body...only a tiny or vestigial stalk at bottom of body.
This photo is to illustrate the extreme end of the type.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

Size range in length: 25 - 55 microns
Note: may occur in all Maranta spp., including Maranta arundinacea
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

Note smooth stalks on wide tips of bodies. Cylinders are covered in projections and surface decoration. Note: may occur in all *Maranta* spp., including *Maranta arundinacea*.

NOTE: In some samples, you may see JUST the tip of the body -- 22VII Ca Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

Note range of variation in size, nature of decoration on cylinders, and proportional length of bodies between bodies on the right and left.
Note: may occur in all Maranta spp., including Maranta arundinacea
Note: you may encounter the “tip” of the body only: see below
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

Typical of leaf samples, both 80IIIB and 80ICa also appeared in the inflorescence sample of this taxon.
Diagnostic level, 80IIIB: family
Diagnostic level, 80ICa:
Marantaceae/Bombacaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

rugulose conical bodies, Leaf sample
Diagnostic level: family
Maranta gibba

Phytolith

Very elongate end of range for this type. Nodular spheres
Diagnostic level:
Marantaceae/Bombacaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

PC2036, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

PC2036, inflorescence
Diagnostic level: genus
View shows the large irregular scallops

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

PC2036, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

PC2036, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

type established by Karol Chandler-Ezell
PC2732 Maranta gibba stem base
Diagnostic level: Calathea/Maranta

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Maranta gibba

Phytolith

type established by Karol Chandler-Ezell
PC2732 Maranta gibba stem base
Diagnostic level: Calathea/Maranta

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Marantochloa hirsuta

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). Y, thin rugose hat-shape from Marantochloa hirsuta leaf+stem. Scale bars=12 μm.

Marantochloa purpurea

Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. G. Marantochloa purpurea (Marantaceae), a druse-like intercostal silica body in a mesophyll cell (bar = 20 µm).

Megaphrynium macrostachyum

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphyrynium clade (V–AA). U, globular-echinate with thin, long echinae from Megaphrynium macrostachyum leaf. Scale bars=12 μm.

Myrosma sp.

Starch

Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. d: Starch granule of Myrosma sp. recovered from flake 3.

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). G, D1 fringed druses from Pleiostachya pruinosa leaf. H, D3 druse with an elongate axis and three main ridges in cross section from Pleiostachya pruinosa leaf. Scale bars=12 μm.

Pleistochya morlaei

Phytolith

PC1826 inflorescence
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pleistochya morlaei

Phytolith

PC1826 inflorescence
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pleistochya morlaei

Phytolith

PC1826, inflorescence
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pleistochya morlaei

Phytolith

PC1825, leaf
In this specimen the bodies are smoother, and sometimes have small projections.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Sarcophrynium sp.

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). V, psilate hat-shapes from Sarcophrynium sp. leaf. Scale bars=12 μm.

Stachyphrynium sp.

**Phytolith**

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). Z, D1 fringed druse from Stachyphrynium sp. leaf. AA, large rugose hat-shape from Stachyphrynium sp. leaf. Scale bars=12 μm.

Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: genus
View is from base

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Type established by Karol Chandler-Ezell, 2004
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: under study
This view shows the round concavities

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC1822, inflorescence
Diagnostic level: under study
This view shows the rounded projections
Stromanthe jarquinii

Phytolith

PC2622, inflorescence
Diagnostic level: Stromanthe, Thalia
This specimen had only short cylinders.
Bottom view
Compare to 22VIIId, Donax

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC2622, inflorescence
Diagnostic level: Stromanthe, Thalia
This specimen had only short cylinders.
Bottom view
Compare to 22VIIId, Donax

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe jarquinii

Phytolith

PC2622, inflorescence
Diagnostic level: Stromanthe, Thalia
This specimen had only short cylinders.
Body on right shows the side view
Compare to 22VIIIDd, Donax

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
4. SEM photograph of a spherical nodular phytolith from Stromanthe lutea (2500 x ).
Stromanthe stromanthonoides

Phytolith

PC1824, inflorescence
Type established by Karol Chandler-Ezell, 2004
Diagnostic level: not diagnostic
Image shows variation in size and shape; note very elongated example

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Stromanthe stromanthades

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). R, flattened globular-granulate from Stromanthe stromanthades fruit bract. S, Kn2 knobby from Stromanthe stromanthades seed. T, Ta5 (irregularly thickened, more or less rectangular with a granulate surface and non-raised central concavity) from Stromanthe stromanthades seed. Scale bars=12 μm.

Stromanthe tonckat

Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). Q, rugose hat-shape with crenate margins from Stromanthe tonckat leaf. Scale bars=12 μm.

Thalia geniculata

Phytolith

PC1156, fruit
Diagnostic level: under study
This specimen had some examples with longer projections; see body below the scale and compare to one above the scale
Rarely observed in Thalia multiflora leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Thalia geniculata

Phytolith

PC1818, inflorescence
Diagnostic level: Stromanthe, Thalia
This specimen has long cylinders
Compare to 22VIIId, Donax
Thalia geniculata

Phytolith

PC1818, inflorescence
Diagnostic level: Stromanthe, Thalia
This specimen has long cylinders
Compare to 22VIIId, Donax

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Thalia geniculata

Phytolith

PC1818, inflorescence
Diagnostic level: Stromanthe, Thalia
This specimen has long cylinders. Image shows an example which lacks projecting tip
Compare to 22VIIId, Donax

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Thalia geniculata

Phytolith

PC1740, root, common.
Type defined by Karol Chandler-Ezell,
11/2004
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Thalia geniculata

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Type defined by Karol Chandler-Ezell, 11/2004
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Thalia geniculata

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Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Thalia geniculata

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PC1740, root, common.
Type defined by Karol Chandler-Ezell, 11/2004
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Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Odontocarya tarnoides

Phytolith

3. Bottom, an irregular pointed phytolith from Odontocarya tarnoides (400 × )

MORACEAE
Artocarpus altilis

Phytolith

Armed hair; hair is bent in a right angle from base, rather than curving as in Boraginaceae Cordia lutea 40IIIAb100. Often has a piece of attached epidermal tissue at base with a “torn” appearance. Distinct multiple outline appearance helps to separate it from similar types. Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Artocarpus altilis

Phytolith

Armed hair; hair is bent in a right angle from base, rather than curving as in Boraginaceae Cordia lutea 40IIIAb100. Often has a piece of attached epidermal tissue at base with a "torn" appearance. Distinct multiple outline appearance helps to separate it from similar types.
Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Artocarpus altillis

Phytolith

Diagnostic level: family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Brosimum discolor

Phytolith

3. Non-segmented hairs with rounded tips from Brosimum discolor (250 x)

Castilla elastica

Phytolith

2. A non-segmented armed hair with an unarmed apex from Castilla elastica (250 × )

Chlorophora tinctoria

Phytolith

4. Stellate-shaped hair base from Chlorophora tinctoria. It is surrounded by epidermis with spherical inclusions (200 x ).

Ficus americana

Phytolith

2. Hair base with irregular striations radiating from the center of the cell from Ficus americana (250 x ).
3. Hair base with a regular striated pattern inside of the base from Ficus americana (250x ).

Ficus americana

Phytolith

4. Torpedo-shaped cystolith with a stalk and a rugulose surface pattern from Ficus americana (250 x).
1. Ellipsoidal-shaped cystolith with a rugulose surface pattern from Ficus americana (250 x).

Ficus guianensis

Phytolith

Fig. 5. Phytoliths from dicotyledons. 
o) Trichomes from Ficus guianensis, 
p) Squat trichome from F. guianensis, q) Hair base from F. guianensis leaf.

Perebea xanthochyma

Phytolith

Fig. 3. A probable genus-specific phytolith from the leaves of Perebea xanthochyma (Moraceae). Palynologists often cannot discriminate genera in this family.

**Sorocea muriculata**

**Phytolith**

Fig. 5. Phytoliths from dicotyledons. n) Cystolith from Sorocea muriculata

2. Non-segmented hair with an elongated flat base from Trophis racemosa (200 ×).
3. Non-segmented hair with an elongated indented base from Trophis racemosa (200 ×).

MUSACEAE
Musa sp. and Ensete sp.

Phytolith

Fig. 17. A comparison of leaf phytoliths from Ensete and Musa. From Piperno, 2006. The schematic drawings were originally from Mbida et al., 2001 and the photographs were courtesy of Carol Lentfer.

Fig. 15. Seed phytoliths from Musa acuminata subsp. banksii (left) and Ensete, right. From Piperno, 2006; originally courtesy of Carol Lentfer.

Ensete sp.

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). A, T2 trough with papillae edges from Ensete sp. leaf. B, tabular-microgranulate from Ensete sp. leaf. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Ensete glaucum

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpinae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). C, Ta6 (with central processes which dividing and anastomosing ridges radiate out from) from Ensete glaucum seed. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. A-B. *Ensete glaucum* (Accession No. QH28807)

Musa sp.

Australian Museum, McCown Archaeobotany Laboratory Collection
Musa sp.

Australian Museum, McCown Archaeobotany Laboratory Collection
Musa sp.

Australian Museum, McCown Archaeobotany Laboratory Collection
Musa sp.

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Musa sp.

Australian Museum, McCown Archaeobotany Laboratory Collection
Musa sp.

Australian Museum, McCown Archaeobotany Laboratory Collection
Musa sp.

Australian Museum, McCown Archaeobotany Laboratory Collection
Musa sp.

Phytolith

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x,400x or 600x; scale bars: 20 mm). (a, b) Musa leaf phytoliths showing rectangular/squarish base with protuberances all along the sides of the base and truncated cone (c.f. Fig. 8a, b). Of the three examples shown here, two are viewed looking down into the cone (a, right panel; b) and the other (a, left panel) looking at the cone side-on.

Musa sp.

**Phytolith**

Fig. 8. Modern reference samples ((a, b mounted in Caedax; c–f mounted in glycerol jelly; 400x or 600x; scale bars: 20 mm). (a, b) Musa (AAB group) leaf phytoliths. For detailed descriptions see Mindzie et al. (2001) and Ball et al. (2006). Musa leaf phytoliths consist of a base (mostly rectangular or squarish) with protuberances all along the sides of the base and a raised truncated cone or sub-cylinder (crater). Right panel of (b) shows three phytoliths in a chain, as they form in the leaf. Of the five examples shown here, four are viewed looking down into the crater (b) and the other (a) looking at the crater side-on.

Musa sp.

Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. B. Musa sp. (Musaceae), trough-shaped silica bodies with silica fingers projecting from the base into cell-wall pits (bar = 10µm).

Figure 1. Parameters used for morphometric analysis of volcaniform banana phytoliths.


Musa, cultivated banana leaf. Check depth of trough to separate from just extremely rugulose spheres. Should be thick and blocky. Diagnostic level: genus
Musa sp.

Phytolith

Musa, cultivated banana leaf. Often occur in chains. Should be thick and blocky.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Musa sp.

Phytolith

Musa, cultivated banana leaf. Should be thick and blocky.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Musa sp.

Phytolith

probably calcium carbonate (CaCO3) crystals.
Also observed in Fabaceae, Flaucortiaceae, and Bombacaceae families.
Diagnostic level: not diagnostic

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Musa sp. (ITC 0614, a triploid variety)

Figs. 1-6. (5) SEM of phytolith produced by ITC 0614, a triploid variety: Variant 2 volcaniform irregular base central concave cone, top view.

Musa acuminata ssp.banksii

Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. I-J. Musa acuminata ssp.banksii, Section Eumusa (Accession No. QH067962)

Figure 2. A. Sheet of polygonal and globular seed phytoliths from Musa acuminata ssp. banksii. These morphotypes have craters and were included in the analysis. The plant material was obtained from the Queensland Herbarium (Accession No. QH067962).


Musa acuminata ssp. banksii

Phytolith


Musa acuminata ssp. banksii

Phytolith

Figs. 13-18. (17) SEM of in situ volcaniform phytolith in cross section from Musa acuminata ssp. banksii illustrating orientation along the fibers of the vascular bundle cap. Phytolith is the large bright structure on top of the thick-walled fibers. Backscattered Electron Image. (18) SEM of in situ volcaniform phytoliths from Musa acuminata ssp. banksii illustrating their attachment to surrounding parenchyma cells. Phytoliths are the bright structures. Backscattered Electron Image.

Musa balbisiana

Phytolith

Figs. 7-12. (9) SEM of phytolith produced by M. balbisiana: Variant 6 volcaniform regular base acentric convex cone, side view.

Musa coccinea

Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. A. Musa coccinea (Musaceae), trough-shaped silica bodies overlying a vascular bundle (bar = 10µm).

Musa flava

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). E, T2 trough with papillae on margins from Musa flava sheath. H, cylindrical-rugulate from Musa flava fruit. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Musa ingens

Phytolith

Fig. 16. Seed phytoliths from Musa ingens. From Piperno, 2006; originally courtesy of Carol Lentfer.

**Musa ingens**

**Phytolith**

![Image of Phytoliths](image)

Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. C-D. Musa ingens, Section Ingentimusa (Accession No. WH1)

Musa maclayi

Phytolith

Figure 1 cont. Diagnostic seed morphotypes of wild Musa bananas and Ensete from Papua New Guinea. G-H. Musa maclayi, Section Australimusa (Accession No. MB6)

Musa maclayi

Phytolith

Figure 2. B-C. Examples of volcaniform and globular leaf morphotypes from Musa maclayi (Accession No. NB487) examined in the analysis.

Musa peekelii

Phytolith

Figure 1. Diagnostic seed morphotypes of wild Musa bananas and Ensete from Papua New Guinea. E-F. Musa peekelii, Section Australimusa (Accession No. WNB488).

Musa sapientum

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpinae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). D, T2 trough with papillae on margins from Musa sapientum leaf. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Fig. 3. Various silica body morphologies found in the order Zingiberales. H. Musa schizocarpa (Musaceae), intercostal, epidermal silica sand (bar = 10 µm).

Musa schizocarpa

Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. K-L. Musa schizocarpa, Section Eumusa (Accession No. NB489).

Musa velutiva

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). G, Ta6 tabular from Musa velutiva seed. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Musella lasiocarpa

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). I, Tabular with scalariform ridges and internal outline of phytolith shape, similar to Ta6, from Musella lasiocarpa seed. Scale bars=A, C–S, U–AA=12 μm; B, T, BB=23 μm.
MYRISTICACEAE
Horsfielddia laevigata

Australian Museum, McCown Archaeobotany Laboratory Collection
MYRTACEAE
Syzygium malaccense

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Syzygium malacense

Myrtaceae
Syzygium malaccense
leaf
No. 32
x1000

Myrtaceae
Syzygium malaccense
leaf
No. 32
x500

Myrtaceae
Syzygium malaccense
leaf
No. 32
x1000

Australian Museum,
McCown Archaeobotany
Laboratory Collection
ORCHIDACEAE
Angraecum chevalieri

Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. B. Angraecum chevalieri (Orchidaceae), spherical bodies overlying sclerenchymatous bundle-sheath cells (bar = 10 µm).

Cephalanthera pallens

Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. A. Cephalanthera pallens (Orchidaceae), conical silica bodies with truncated tops (hat shaped) adjacent to phloem cells (bar = 10 µm).

OXALIDACEAE
## Hypsocharis pimillifolia

### Oxalidaceae Hypsocharis pimpimillifolia “soldaue”, wild specie

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuber</td>
</tr>
<tr>
<td>No opal phytoliths (*)</td>
</tr>
</tbody>
</table>

**References:** Reported as a family where phytoliths have been found to be not present, rare or not taxonomically significant in Pearsall 2000:371.

<table>
<thead>
<tr>
<th>Starch assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuber</td>
</tr>
<tr>
<td>a) Mainly single grains, oval, sausage-shaped, and triangulate with round sides and vertex; variable in size commonly from 15μm to 25μm, but also more than 40μm long length; not visible hilum; sometimes very distinct lamella; sometimes a fissure in a regular line, or a central circular to oval hollow; distinct, mainly centric but variable placed cross, with four arms visible, equal or two long and two short, intersecting in a line or meeting two by two. A few subspheric grains with a central circle formed by the arms of the cross.</td>
</tr>
<tr>
<td><img src="image1.png" alt="Images of starch granules" /> <img src="image2.png" alt="Images of starch granules" /> <img src="image3.png" alt="Images of starch granules" /> <img src="image4.png" alt="Images of starch granules" /> <img src="image5.png" alt="Images of starch granules" /> <img src="image6.png" alt="Images of starch granules" /></td>
</tr>
<tr>
<td>b) Rarely compound grains, oval, from 20μm-22μm, compounded by variable number of granula. Granula different in shape and size.</td>
</tr>
</tbody>
</table>

Scale bar = 20μm.
Oxalis tuberosa

### Oxalidaceae Oxalis tuberosa “oca”

#### Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>Seed</th>
<th>No phytoliths (*)</th>
<th>References: Reported as a family where phytoliths have been found to be: not present, rare or not taxonomically significant (Pearsall 2000:371).</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Leaf</th>
<th>No diagnostic phytoliths and oxalates (*)</th>
<th>References: Reported as a family where phytoliths have been found to be: not present, rare or not taxonomically significant (Pearsall 2000:371).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Some non diagnostic phytoliths (<em>) and oxalates (</em>)</td>
<td>a) Globose irregularly lobated silica phytolith. Rare.</td>
</tr>
<tr>
<td></td>
<td>b) Sub-spherical irregularly shaped oxalates. Common.</td>
<td>c) Round planar silica phytolith. Rare.</td>
</tr>
</tbody>
</table>

| Flower | No diagnostic phytoliths. (*) | a) Round with a central density silica phytolith. Rare. |

### Starch assemblage characterization

<table>
<thead>
<tr>
<th>Tuber</th>
<th>a) Single grains, globular or subglobular; less than 7 μm.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b) Single grains, generally asymmetrical, irregular, pear-shaped, prismatic, ovoid, oval and spherical, sometimes with a partially truncate-rounded end; from 10 μm to 60 μm long length; distinct highly eccentric hilum as a circle or line; very distinct lamella; radiating lines from the hilum to the border of grain; sometimes a centric fissure; distinct eccentric cross to one end, with irregular, broken dark arms intersecting at more than one point, fibrous appearance.</td>
</tr>
<tr>
<td></td>
<td>c) Compound grains compounded by two-five granula. Granula, generally unequal and asymmetrical.</td>
</tr>
</tbody>
</table>

Scale bar = 20 μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
PIPERACEAE
Piper aduncum

Phytolith

Slide 1397a; Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1397a; Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1397a; Leaf
Picture shows a broken hair without the tip

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

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Piper aduncum

Phytolith

Slide 1397a; Leaf
Hair shaft still attached to base

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1397a; Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1397a; Leaf
Picture shows four highly silicified central cells

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1397a; Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1397a; Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1397a; Leaf

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Pipers, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1398a. Inflorescence. Picture only shows one segment of a hair.
Piper aduncum

Phytolith

Slide 1398a. Inflorescence

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1398a. Inflorescence
Segments often occur individually or in pairs throughout slide
Piper aduncum

Phytolith

Slide 1398a. Inflorescence
Segments often occur individually or in pairs throughout slide
Piper aduncum

Phytolith

Slide 1398a. Inflorescence

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper aduncum

Phytolith

Slide 1398a. Inflorescence.
Picture shows hair base with hair attached and to the far right a hair base without hairs attached.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
**Piper aduncum**

**Phytolith**

Slide 1398a. Inflorescence.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Piper flagellicuspe

Phytolith

2. Hair cell phytoliths with two rounded ends from Piper flagellicuspe (400 x ).

Piper pseudoasperi

Phytolith

4. Segmented hair with long distinct striations on the surface from Piper pseudoasperi (400×).

POACEAE
Panicoideae

Phytolith

i. Charred silicified sheet fragment of long-cells and bilobate-type short-cells diagnostic of the Poaceae subfamily Panicoideae, and likely derived from leaf material.

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. a) Panicoideae cross-shaped phytolith (BD M1, 10-20 cm).

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. b) Oryzoideae scooped bilobate (P. Ridged Field 2, 0-10 cm).

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. f) Pooideae oblong phytolith (BD M1, 40-50 cm).

Olyreae

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. g) Olyreae Phytolith with irregular concavities and pointed edges (K-VIII M 1.1. 0-10 cm).

Actinocladum merticulatum

Phytolith

FIGURES 69-72.-69, A two-peaked conical siliceous body from Actinocladum merticulatum (x400).

Aegilops triaristata

Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. D. Aegilops triaristata, a horizontally elongated silica body with sinuous outlines (bar = 10 µm).

Aegopogon cenchroides

Phytolith

FIGURES 53-56.-56, A phytolith from Aegopogon cenchroides (x400)

Agropyron elongatum

Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. G. Agropyron elongatum, a conical silica body (bar = 20 µm).

Andropogon bicornis

Phytolith

FIGURES 5-8. 7, Center, a bilobate with squared lobes and a distinct, moderately thin shaft from Andropogon bicornis (x200)

Andropogon leucbostacbya

Phytolith

FIGURES 5-8. 5, Bilobates with semirounded lobes and long, thin shafts from Andropogon leucbostacbya (x200).
Anthochloa lepidula

Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. E. Anthochloa lepidula, horizontally elongated bodies with smooth outlines (bar = 20 µm).

Apochiton burttii

Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. C. Apochiton burttii, cross-shaped silica bodies (bar = 10 µm).

Arberella dressleri

Phytolith

FIGURES 17-20. 17, A Variant 3 cross-shaped phytolith from Arberella dressleri with conical protrusions on the upper face (x400).

Arberella dressleri

Phytolith

FIGURES 41-44. 42, A phytolith From Arberella dressleri with one sinuous and one concave, irregularly pointed edge (x400). 43, A phytolith from Arberella dressleri with one sinuous and one concave, irregularly pointed edge (x400). 44, A phytolith from Arberella dressleri with one sinuous and one irregularly pointed edge (x400)

Arberella dressleri

Phytolith

FIGURES 45-48. - 47, A Variant 3 bilobate phytolith from Arberella dressleri. The phytolith is partially turned, revealing aspects of both of its faces (x400)

**Aristida sp.**

![Phytolith](image)

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. c) Aristida sp. bilobate (GM RP, 0-15 cm)

Aristida mendocina

Starch

Fig. 3. Pampean native wild grasses from reference collection. F-G: Compound starch grains, supernumerary aggregates of class b. F: Aristida mendocina. (Scale bars: 10 mm).

Aristida orizaliensis

Phytolith

FIGURES 5-8. 8, Bilobates with semirounded lobes and long, thin shafts from Aristida orizaliensis (x200)

Aristida orizaliensis

Phytolith

Figures 53-56. Top, a rondeloid/saddleloid phytolith from Aristida orizaliensis. Also present is a bilobate (x400).

Aristida orizaliensis

Phytolith

FIGURES 65-68. 65, An odd silica body with saddle tendencies from the culm of Aristida orizaliensis (x400). 66, An unusual silica body from the inflorescence of Aristida orizaliensis (x400).

Aristida recurrata

Phytolith

FIGURES 53-56.-53, A rondeloid/saddeloid phytolith from the inflorescence of Aristida recurrata. As the name implies, it exhibits features characteristic both of phytoliths in the Pooideae and Chloridoideae (x400).

Aristida setigera

Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. A. Aristida setigera, costal dumbbell-shaped silica bodies (bar = 10 µm).

Aristida ternipes

Phytolith

FIGURES 61-64.-64, An odd silica body from the culm of Aristida ternipes (x400)

Aristida tincta

Phytolith

Fig. 4. Phytoliths from Poaceae. b) Prickle-type hair from Aristida tincta, c) Aristida-type bilobate from Aristida tincta d) Rondeloid/saddleoid phytolith from A. tincta

Arundinella confinis

Phytolith

FIGURES 49-52. 51, A phytolith from Arundinella confinis marked by considerable width and the presence of one slightly concave and one somewhat sloping edge (x400). 52, A phytolith from Arundinella confinis marked by considerable width and the presence of one somewhat concave and one somewhat sloping edge (x400)

Astrebla squarrosa

Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. F. Astrebla squarrosa, saddle-shaped silica bodies (bar = 10 µm).

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Axonopus aureus

Phytolith

Fig. 4. Phytoliths from Poaceae. a) Bulliform cell from Axonopus aureus

Axonopus aureus

Phytolith

Fig. 4. Phytoliths from Poaceae. k) Bilobate from Axonopus aureus

Bathriochloa ischaemum

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 7. Bathriochloa ischaemum

Brachiaria jubata

Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. B. Brachiaria jubata, a form of silica intermediate between the dumbbell-shaped form and the cross-shaped form (bar = 10 µm).

Bromus auleticus

Starch

Fig. 3. Pampean native wild grasses from reference collection. A-C: Simple starch grains. B and C: Bromus auleticus. (Scale bars: 10 mm).

Buchloe dactyloides

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 11, 12. Buchloe dactyloides

Cencrus echinatus

Starch

APPENDIX:
Cencrus echinatus. Compound grains, with many pressure facets. The double border is visible on part of the grain. The hilum is centrally located and the central fissures can be deep and distinct. Indistinct radiating fissures are present. Size: 10–16 microns long.

Chimonobambusa quagrangularis

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 9. Chimonobambusa quagrangularis

Chloris eiliata

Phytolith

FIGURES 17-20. 18, Center, two squat saddles, and top, a tall saddle from Chloris eiliata (x400).

Chusquea sp.

Phytolith

FIGURES 69-72: Top, a Chusquea-body phytolith as it would appear in leaf tissue. Below is a Chusquea-type bilobate (x400)

Chusquea grandiflora

Phytolith

FIGURES 25-28. 26, A collapsed saddle from Chusquea grandiflora (x400). 27, A partially collapsed saddle from Chusquea grandiyora (x400). 28, A two-spiked-side phytolith from Chusquea grandiflora. Spikes are present on the bottom of the phytolith (x400).

Chusquea grandiflora

Phytolith

FIGURES 29-32.-29, Center, a saddle with a ridged platform from Chusquea grandiflora (x400). 31, A saddle bilobate both sides type of phytolith from Chusquea grandiflora (x400).

Chusquea longifolia

Phytolith

FIGURES 13-16. 13, Bilobates from the culm of Chusquea longifolia (x400).

Chusquea longifolia

Phytolith

FIGURES 57-60. Center, bilobates from the inflorescence of Chusquea longifolia. They are attached to two elongated phytoliths (x200).

Chusquea patens

Phytolith

FIGURES 9-12. 10, A row of bilobates from Chusquea patens (x200). Their morphology, although not overlapping the panicoid types, is unusual for bamboos

Chusquea pittieri

Phytolith

FIGURES 33-36.-33, A multifaceted Chusquea-body phytolith from Chusquea pittieri (x400).

FIGURES 49-52.-50, A cross-shaped phytolith from Chusquea pittieri with serrated short axes, three indentations, and a concave face (x400). This phytolith is not as thick as is usual in the genus.

Chusquea pohlii

Phytolith

FIGURES 9-12. 12, Bilobates in tissue from Chusquea pohlii (x200).

FIGURES 29-32. Right and left, Chusquea-body phytoliths diagnostic of this genus from Chusquea simpliciflora. The phytolith on the bottom left is still orientated as it would appear in the leaf (x200). The center phytolith is a bilobate.

Coix lacryma-jobi var. ma-yuen

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 8. Coix lacryma-jobi var. ma-yuen

Coix lacryma-jobi

Starch

Cortaderia speciosa

References: Reported in Zucol 1999 for *Cortaderia selloana*.

Scale bar = 20μm.
Criciuma asymmetrica

Phytolith

FIGURES 29-32.-30, A
Chusqoid body from Criciuma asymmetrica. This phytolith, unlike the Chusquea body, is fairly widely distributed in bamboos (x400).

Cynodon dactylon

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 5, 10. Cynodon dactylon

Dactyluctenium aegpticum

Phytolith

FIGURES 17-20. 20, Saddle-shaped phytoliths from Dactyluctenium aegpticum. Many of them are squat (x200).

Distichlis spicata

Phytolith

Fig. 4. Phytoliths from Poaceae. h) Spooled/horned towers from Distichlis spicata

Echinolaena inflexa

Phytolith

Fig. 4. Phytoliths from Poaceae. p)
Fan-shaped rondel from Echinolaena inflexa

Elionorus muticus

Starch

Fig. 3. Pampean native wild grasses from reference collection. D-E: Compound starch grains as discrete aggregates of class a. E: Elionorus muticus. (Scale bars: 10 mm).

Elytrostachys clanisera

Phytolith

FIGURES 65-68. 67, Top, conical siliceous bodies emerging from the leaf epidermis of Elytrostachys clanisera (x400). 68, Two-peaked conical siliceous bodies in epidermis from Elytrostachys clanisera (x200).

Eragrostis mexicana

Phytolith

FIGURES 13-16. 14, A bilobate (left) and a cross-shaped phytolith (right) from Eragrostis mexicana (x200). The bilobate has four indentations and both phytoliths have the flared edges typical of the Chloridoideae. 15, Center, a complex bilobate from Eragrostis mexicana with multiple indentations (x200).

Guadua amplexifolia

Phytolith

FIGURES 21-24.-21, Saddle-shaped phytoliths from Guadua amplexifolia. All but one are tall (x200). 22, Saddle-shaped and narrow-elliptical phytoliths from Guadua amplexifolia. All of the saddles are very tall (x200)

Guadua amplexifolia

Phytolith

FIGURES 73-76.
75, Right, a thick, collapsed saddle from Guadua amplexifolia (x400). 76, A phytolith with both saddle and bilobate characteristics from Guadua amplexifolia (x400).

Guadua angustifolia

Guadua angustifolia

Phytolith

FIGURES 61-64.-62, Narrow elliptate phytoliths from Guadua angustifolia removed from tissue (x400).

Guadua latifolia

Phytolith

Guadua latifolia

Phytolith

FIGURES 57-60-58, Center, a bilobate from the inflorescence of Guadua latifolia (x400).

FIGURES 61-64-61, Narrow elliptate phytoliths from Guadua latifolia still enclosed in tissue (x400).

Gynerium sagittatum

Phytolith

FIGURES 57-60.-57, A phytolith typically produced in the leaves of Gynerium sagittatum (x400).

FIGURES 61-64.-63, A narrow elliptate phytolith from Gyneriurn sagittatum (x400).

FIGURES 73-76.-74, A typical phytolith from Gynerium sagittatum (x400).

Gynerium sagittatum

Phytolith

Fig. 4. Phytoliths from Poaceae. e) Elliptoid/biloboid phytolith from Gynerium sagittatum

Fig. 10. An articulated aggregation of inflorescence bract phytoliths from Hordeum vulgare showing the long cell wave patterns and papillae characteristic of Hordeum sp. Photo by Arlene M. Rosen from modern plant phytolith reference collection at ICREA, University of Barcelona, courtesy of Rosa M. Albert

Hordeum vulgare

Starch

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Hordeum vulgare

Starch

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Indocalamus tessellates

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 13. Indocalamus tessellates

Isachne arundinaceae

Phytolith

FIGURES 73-76.-73, A tall saddle from Isachne arundinaceae (x400). 74,)

Isachne polygonoides

Phytolith

Fig. 4. Phytoliths from Poaceae. i) Tall saddles from Isachne polygonoides, j) Saddleoid/biloboid phytoliths from Isachne polygonoides

Maclurolyra tecta

Phytolith

FIGURES 9-12. 11, A bilobate from Maclurolyra tecta (x200).

FIGURES 37-40.-39, An irregular, complex short-cell phytolith from Maclurolyra tecta orientated as it would be in leaf tissue (x400). Compare with Figure 40. 40, An irregular, complex short-cell phytolith from Maclurolyra tecta exhibiting extreme width and one sinuous and one sloping edge (x400).

Miscanthus floridulus

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 4. Miscanthus floridulus

Msicanthus sinensis

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 14. Msicanthus sinensis

Muhlenbergii emersleyi

Phytolith

FIGURES 17-20. 19, Saddle-shaped phytoliths from Muhlenbergii emersleyi. Many of them are squat saddles (x200).

Fig. 3. Pampean native wild grasses from reference collection. F-G: Compound starch grains, supernumerary aggregates of class b. G: Nasella clarasii. (Scale bars: 10 mm).

Neurolepis pittiera

Phytolith

FIGURES 33-36.-35, A small, wide, tent-shaped body from Neurolepis pittiera (x400).

Olyra latifolia

APPENDIX:
Olyra latifolia. Compound grains, with pressure facets. A double border is visible and a cavity is usually found at the hilum. Size: 4–8 microns.

Panicum

Olyra latifolia

Phytolith

FIGURES 45-48. 45, Top and bottom, irregular, complex short-cell phytoliths from Olyra latifolia. These phytoliths are characteristic of the tribe Olyreae. The phytolith in the center is a bilobate (x200). 48, Center, two Variant 8 bilobates from Olyra latifolia (x400).

Oplismenus compositus

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 16. Oplismenus compositus.

Oplismenus undulatifolius

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 15. Oplismenus undulatifolius

Oryzeae tribe

Fig. 2. Phytolith types distinguishing the Oryzeae tribe, a: Type 1 dumbbell with scooped ends, curved and lobed in side view (fight), thick. The most common short cell in many taxa in the tribe. Grades into a scooped cross-like form; b: Type 8a short cell with a dumbbell on one tier (bottom view, lower), and a thin plate extending perpendicular to the dumbbell-type tier (side view, right); c: Type 5 thick cross, lobed in side view (fight), with raised corners. Common in two genera (a--c short cells not drawn to scale. Size 15-25 micrometers); d: 10IIEf epidermal long cell, weakly silicified, with regular, well-silicified, rounded projections (example from Oryza sativa); e: I IIII Ca. 1 IIII Ca--Cc are blockly epidermal cells with numerous projections of variable size, and sometimes with one prominent projection (example from Oryza manilensis); f: 1 IIII Cc, top view (example from Oryza sativa); g: same as f, side view; h: 50III Ac. 50III Aa, b, and c are keystone bulliform types, sometimes thick and with multiple ridges (example from Oryza meyeriana); i: 50III Ab (example from Oryza minuta); j: 50III Aa (example from Oryza manilensis). Scale bar = 20 micrometers.

Oryza sp.

Phytolith

Fig. 3. Epidermal and bulliform types distinguishing the genus Oryza. a: 22IIIAa and 22IIIAb. Seed epidermis with large conical hairs (22IIIAa: 1 peak, 22IIIAb: two peaks) arising from very deeply serrated cells. Large hairs may be flanked by smaller projections (example from Oryza sativa); b: 22IVA. Seed epidermis, very deeply serrated, with pointed serrations (example from Oryza sativa); c: 22IVB. Seed epidermis, very deeply serrated, with sinuous-edged serrations (example from Oryza sativa); d: 50IIIAc1 and 50IIIAc2. Very widely flared keystone bulliform cells, a number of forms, varying by the extent of flaring and width of top. Bases symmetrical (example from Oryza sativa); e: 50IIIB301. Small, moderately flared keystone bulliform cells (example from Oryza minuta). Scale bar = 20 micrometers.

Oryza sp.

Phytolith

Fig. 4. Measurements of keystone bulliforms, shown from side view (upper) and top view (lower). HL: horizontal length (length of base); LL: lateral length (width of side); VL: vertical length; B: length of base portion.

Oryza sp.

Phytolith

Fig. 2. Phytolith types from rice and morphological parameters: bulliform (left); double-peaked (center); bilobate (right). Abbreviations in bulliform: HL (horizontal length); VL (vertical length); LL (lateral length); a (vertical length of the non-base portion); b (vertical length of the base portion). Abbreviations in double-peaked: TW (top width); MW (middle width); H1, H2 (height 1, height 2); CD (curve depth).

Oryza sp.

Phytolith

Fig. 13. Double-peaked glume cell phytoliths from Oryza. From Piperno, 2006. Originally re-printed from Zhao et al., 1998

Fig. 2. Oryza double-peaked husk cells from Qingpu. (A) and (D) 68e70 cm, 1870 BP, darker colour suggests likely burnt; (B) 82 cm, ca. 1940 BP; (C) 98 cm, ca. 2010 BP.
Oryza sp.

Phytolith

Fig. 3. Measurements of double-peaked rice Oryza husks required to distinguish between wild, domesticated or indeterminate varieties based on discriminant function formulas developed by Zhao et al. (1998). TW, distance between the two peaks; MW, width at the point where the hair attaches to the base; H1, height of largest peak, measured from the tip to the base of the hair; H2, height of smallest peak, measured from the tip to the base of the hair; CD, depth of the curve (adapted from Zhao et al., 1998).

Oryza sp.

Phytolith

Fig. 2. 3-D scattered plots for morphological parameters of double-peaked glume cells from Shangshan Period (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve Scale bars ¼ 20 µm

Oryza sp.

Phytolith

Fig. 6. Domesticated double-peaked phytoliths from Wormsloe.

Oryza sp.

Phytolith

Fig. 14. Comparison of the scale-like decorations on bulliform phytoliths in domesticated and wild rice. Modified from Fujiwara (1976)


Fig. 5. Scale-like decorations on cuneiform bulliform cells phytoliths. A, B modified from Lu et al. (17) A. domestic rice with 11 scale-like decorations; B. Wild rice with 6 scale-like decorations. C, D. cuneiform bulliform cells phytoliths extracted from the Shangshan Period (around c. 11,000e9000 cal. BP). C. shows 11 scale-like decorations; D. shows 6 scale-like decorations. Scale bars $\frac{1}{4}$ 20 µm

Fig. 4. Optical micrographs of fossil rice phytoliths from the DG9603 core. A, B, C, F. Bulliform phytolith (fan-shaped) with more than nine small shallow scale-like decorations on the half round side. D, E. Dumbbell-shaped with scooped ends, paralleled arrangement. Scale bar = 10 µm.
Fig. 4. Domesticated bulliform phytoliths from Wormsloe.
Fig. 4. Domesticated bulliform phytoliths from Wormsloe.

Oryza sp.

Phytolith

Brazilian rice bulliforms. Scale bar is 50 µm

Fig. 2. Long cells in domesticated and wild rice species. (A) Irregular elongate with short protrusions. (B) Elongate sinuate. (C) Elongate echinate. (D) Elongate smooth. a: O. minuta, inflorescence; b: O. granulata, inflorescence; c, h: O. rufipogon, inflorescence; d, k: O. longiglumis, inflorescence; e, l: O. meyeriana, inflorescence; f-g, i-j, m: O. sativa, inflorescence; n, u: O. minuta, leaf; o: O. longiglumis, leaf; p-q, r-t, v, w: O. sativa, leaf. Scale bar ¼ 20 mm
Fig. 3. Parallelepipedal bulliform cells from the leaves of eight rice species in East Asia. (A) Parallelepipedal bulliform cells. (B) Parallelepipedal bulliform cells. a, c: O. minuta; b, d-f, i, p: O. sativa; g-h: O. ridleyi; j: O. granulata; k: O. meyeriana; l: O. Officinalis; m-n: O. rufipogon; o: O. longiglumis. Scale bar ¼ 20 mm.

**Phytolith**

Fig. 4. Hair cells, papillae cells, tracheid and vascular tissue and other phytoliths in domesticated and wild rice species. (A) Hair cells. (B) Papillae cells. (C) Cylindric sulcate tracheids. (D) Vascular tissues. (E) Irregular epidermal phytoliths. (F) Mesophyll tissue, O. sativa, leaf. (G) Silicified epidermal tissue with rondels and irregular long cells, O. ridleyi, inflorescence. a, n: O. ridleyi, inflorescence; b, g, l, s, u: O. sativa, inflorescence; c, o: O. granulate, leaf; d-f, j-k, m, r, x: O. sativa, leaf; h, i: O. minuta, inflorescence; p, v, w: O. meyeriana, inflorescence; q, t, y: O. rufipogon, inflorescence. Scale bar ¼ 20 mm

Fig. 5. Bilobates from the leaves of O. sativa and wild rice species in East Asia. a, b: O. granulata; c: O. longiglumis; d O. meyeriana; e, g: O. officinalis; f: O. ridleyi; h: O. rufipogon; i: O. minuta; j-k: O. sativa; l: Parallelled arrangement for bilobates in the silicified issue from the leaf of O. longiglumis; m: Parallelled arrangement for bilobates in the silicified issue from the leaf of O. sativa parallelled bilobates. Scale bar ¼ 20 mm.
Fig. 6. 3-D scattered plots for morphological parameters of bilobates (a), cuneiform bulliform cells (b) and double-peaked glume cells (c) in Oryza species. (L) Vertical length. (W) Width of the lobe. (a) Width of the shank. (b) Width of the scooped end at the top of the lobe. (HL) Horizontal length. (LL) Lateral length. (VL) Vertical length. (B) Length of base portion. (A) Length of non-base portion. (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve.
Fig. 6. 3-D scattered plots for morphological parameters of bilobates (a), cuneiform bulliform cells (b) and double-peaked glume cells (c) in Oryza species. (L) Vertical length. (W) Width of the lobe. (a) Width of the shank. (b) Width of the scooped end at the top of the lobe. (HL) Horizontal length. (LL) Lateral length. (VL) Vertical length. (B) Length of base portion. (A) Length of non-base portion. (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve.
Oryza sp.

Phytolith

Fig. 6. 3-D scattered plots for morphological parameters of bilobates (a), cuneiform bulliform cells (b) and double-peaked glume cells (c) in Oryza species. (L) Vertical length. (W) Width of the lobe. (a) Width of the shank. (b) Width of the scooped end at the top of the lobe. (HL) Horizontal length. (LL) Lateral length. (VL) Vertical length. (B) Length of base portion. (A) Length of non-base portion. (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve.

Oryza sativa

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 6. Oryza sativa

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Otatea fimbriata

Phytolith

FIGURES 49-52.-49, A thick, cross-shaped phytolith with a concave face from Otatea fimbriata (x400). Most cross-shaped phytoliths from this species have only three indentations.

Panicum cyanescens

Phytolith

Fig. 4. Phytoliths from Poaceae. I) Squat bilobate from Panicum cyanescens

Panicum fasciculatum

Phytolith

FIGURES 5-8. 6, Bilobates and a complex bilobate from Panicum fasciculatum (x200).

Panicum mertensii

Starch

APPENDIX:
Panicum mertensii. Simple and compound grains, spherical, very often with an ornamented border. Indistinct radiating fissures are present and a double border may be prominent. Size: 4–10 microns.

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Panicum urvilleanum

Starch

Fig. 3. Pampean native wild grasses from reference collection. A-C: Simple starch grains. A: Panicum urvilleanum. (Scale bars: 10 mm).

Pariana campestris

Phytolith

FIGURES 41-44.-41, A phytolith from Pariana campestris with one sinuous and one sloping edge. It is neither as tall nor as wide as that from Maclurollya tecta (x400).

Pariana campestris

Phytolith

FIGURES 45-48.-46, An irregular, complex short-cell phytolith from Pariana campestris (x400).

Parodiolyra luetzelbergii

Phytolith

Fig. 4. Phytoliths from Poaceae. f) Irregular/complex phytoliths (1) from Parodiolyra luetzelbergii. Bilobate (2) to the right is variant 3/8

Paspalum sp.

Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 3. Paspalum sp.

Paspalum lividum

Phytolith

Tubular body
These bodies are very similar to the narrow rectangular IRP, but are tubules, not flattened pieces. These occur mostly in non-Zea grasses and rarely in Zea spp. Diagnostic level: wild Poaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Paspalum lividum

Phytolith

Burr-like spheres and elongate bodies with needle projections.
Occur mainly in Digitaria spp. and in Arundinella hispida, but not in Zea spp.
Diagnostic level: wild Poaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Fig. 4. Phytoliths from Poaceae. m) Polybate from Paspalum parviflorum, n) Cross from P. parviflorum

Pharus sp.

Phytolith

FIGURES 33-36. A Pharus body characterized by its flatness, considerable width, and presence of (bottom left) dumbboid and (upper right) rectanguloid lateral edges (x400).

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. h) Phragmites large ridged saddle (P Ridged Field 2, 10-20 cm).

**Phragmites australis**

**Phytolith**

FIGURES 21-24.-24, Center, a plateaued saddle from *Phragmites australis* (x400)

FIGURES 25-28.-25, A plateaued saddle from *Phragmites australis* (x400)

Phragmites australis

Phytolith

FIGURES 57-60. A tall saddle from Phragmites australis (x400)

Phragmites australis

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 1, 2. Phragmites australis

Polypogon elongatus

Phytolith

FIGURES 53-56. A unique type of cross-shaped phytolith, from Polypogon elongatus, in which one side of the phytolith has a saddle- or bilobate-like structure that extends only about two-thirds the length of the longer, cross-shaped side. It is also very wide. The phytolith is slightly turned, thus both faces may be seen (x400). Bilobates from this grass also carry the same features.

Raddiela nana

Phytolith

FIGURES 37-40.-37. A biloboid from Raddiela nana enclosed in a siliceous plate (x400). 38. A cross-shaped-like phytolith from Raddiela nana enclosed in a siliceous plate (x400).

**Sorghastrum pellitum**

**Starch**

Fig. 4. Classic Panicoid starch grain morphotype of Sorghastrum pellitum. A: Example of centric hilum as a deep depression. B: Same starch grain with polarized light. C: Example of facetted shapes with angular edges. D: Same starch grain with polarized light. E: Example of simple starch grains with transverse fissures. F: Same starch grain with polarized light (Scale bars: 10 mm)

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

### Sorghum bicolor

#### Starch

<table>
<thead>
<tr>
<th>Ground and Soaked</th>
<th>Ground and Boiled</th>
<th>Baked</th>
<th>Parched</th>
<th>Popped</th>
<th>Fermented</th>
<th>Ground and Fermented</th>
</tr>
</thead>
</table>
| ![Ground and Soaked Image](image1)
| ![Ground and Boiled Image](image2)
| ![Baked Image](image3)
| ![Parched Image](image4)
| ![Popped Image](image5)
| ![Fermented Image](image6)
| ![Ground and Fermented Image](image7) |

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Spartina alterniflora

Fig. 4. Phytoliths from Poaceae. g) Rondeloid/saddleoid phytolith from Spartina alterniflora

Sporobolus rigens

Starch

Fig. 3. Pampean native wild grasses from reference collection. D-E: Compound starch grains as discrete aggregates of class a. D: Sporobolus rigens. (Scale bars: 10 mm).

Stipa ichu

Phytolith

A rondel from Stipa ichu (400x)

Trachypogon spicatus

Phytolith

Fig. 4. Phytoliths from Poaceae. o) Spooled/horned towers from Trachypogon spicatus

Tripsacum dactyloides

Starch

Starch grains from seeds of modern Tripsacum dactyloides. They have prominent radiating fissure 400x

APPENDIX:
Tripsacum dactyloides (Figure 8). Simple and compound grains, spherical, with one or more slight depressions. The hilum is large in relation to the size of the grain. The radiating fissures are very prominent. The double border is not conspicuous and often not continuous. Size 2–10 microns long.

Tripsacum lanceolatum

Phytolith

Fig. 7. A Tripsacum-specific fruitcase phytolith from T. lanceolatum. It has markedly serrated edges and possesses ridges on the top.

Tripsacum lanceolatum

Phytolith

FIGURES 69-72.-70, A genus-specific epidermal-cell phytolith from the fruitcase of Tripsacum lanceolatum (x400).

Tripsacum sp.

Fig. 4. Tripsacum fruitcase phytoliths. Unlike those of teosinte or maize, they have serrated edges and ridges across the top. Piperno 2006


Fig. 9. An articulated aggregation of inflorescence bract phytoliths from *Triticum aestivum* showing the long cell wave patterns and papillae characteristic of *Triticum* sp. Photo by Arlene M. Rosen from modern plant phytolith reference collection at ICREA, University of Barcelona, courtesy of Rosa M. Albert.
Triticum aestivum

Starch

Fig. 1. Comparisons of raw and boiled starch grains showing damage to extinction crosses. (a) Wheat starch grains. Left side, raw wheat starch grain; right side, wheat starch grain boiled for 10 min. Notice there is very little change to the grain under regular light, but the extinction cross is much faded and with a very wide center. Each image is 50 mm wide.

Triticum aestivum

Starch

![Starch Images](image)

Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.
Triticum aestivum

Phytolith

FIGURES 21-24.- 23, Top, a long, wavy trapezoid from Triticum aestivum (x400).

Zea luxuriens

Phytolith

Diagnostic level: genus
Half-decorated rondel. Found in high numbers in teosinte fruit cases, and in very low numbers in some types of maize. A good Zea indicator, and is especially characteristic of teosinte and primitive maize. The body illustrated shows very long speculative projections. See other illustration for range of variation.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea luxuriens

Phytolith

Sheet of robust globular bodies. Robust globular bodies occur in maize and teosinte only, and are good Zea spp. indicators.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea luxuriens

Phytolith

Diagnostic level: genus
Robust globular body.
Long sides are roughly parallel. Body may be two-dimensional and flattened, or more three-dimensional (i.e. thickness may vary considerably). Sides may be undulating, but may not be crenate.
Projections may be distributed regularly or irregularly, as long as they are along

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Phytolith

Half-decorated oblong body Differs from the 1/2 decorated rondel only in that their bases are blocky, square or rectangular, not a rondel. Often occur in dense sheets in teosinte. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea luxuriens

Phytolith

Diagnostic level: genus Half-decorated rondel
Found in high numbers in teosinte fruit cases, and in very low numbers in some types of maize.
This is a good Zea indicator, and is especially characteristic of teosinte and primitive maize.
The body illustrated here shows the beadlike projections. See other

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Zeama

Starch

Zea mays

Figure 6. Starch of maize tostado showing roasting effects. (a) A charcoal particle, a very flat relief grain, clumps of gelatinised granules and grains with pronounced projections at the hilum are marked with arrows. View with normal light (left). (b) A starch grain with weak birefringence is marked with an arrow. View with polarised light (right). Scale bar = 40μm.

Zea mays

Starch

Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. c: Starch granule cluster of Zea mays recovered from flake 3

Figure 5. Example of maize starch grain on mano from Chiripa Quispe (Locus 3132), in transmitted (left) and polarized (right) light.

Zea mays

Starch

Zea mays

Starch

APPENDIX:
Zea mays (maize) (Figures 9 and 10). Simple and compound grains, spherical, or with irregular depressions and pressure facets. The grains often have a distinct and continuous double border and radiating fissures. Deep, central fissures may be present. Size: 6–14 microns long (Race Pepetilla), 4–18 microns long (Argentine popcorn), 4–14 microns long (modern cobs from Panama).

Zea mays ssp. parviglumis (teosinte). Simple and compound grains, spherical to bell-shaped, with slight depressions or pressure facets. Double border is indistinct and discontinuous, and radiating fissures are not as defined as in other grasses. The hilum is central and the central fissures are deep and distinct. Size: 4–14 microns long

Fig. 5. Selected microbotanical remains. Starch grains: a) Zea mays (SAL 06-10-1642)

Zea mays

Starch

Figure 1. Various starch grains. d, A starch grain from maize from milling stone 42. This type is unique to maize and is found in Race Jala from Mexico. Scale 5 µm.

**Zea mays**

**Starch**

Fig. 5. Comparative maize starch, a: polarized light view of Peruvian sweet corn; b: Reventador popcorn; c: Chapalote flint corn; d: Guatemalan red flour corn; e: Cuzco flour corn; f: Peruvian sweet corn.

Zea mays

Starch

Fig. 7. Archaeological maize starch, a, b, c, d, from 3290-A; e: 3290-B; f: 3293-A, g: 3293-B, h: 3294-A; i, j, k: 3294-B; l, m, n: 3331-A; o: 3383-A, p: 3383-B, q: 3386; r: 3415-A, s: 3415-B, t: 3417-A.

Zea mays

Starch

Fig. 2. Selected archaeological starch grains. (C) Maize (Z. mays) starch from Hornito, wedge 77-1, ?7000 cal BP. (G) Maize starch from Ladrones, triangular grinding stone CL-82b, ?7800 cal BP. Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.

Zea mays

Starch

Fig. 1. Starch grains from teosinte and maize. (a) Starch grains from Zea mays ssp. parviglumis. It can be seen that in contrast to maize (c and d) the majority of grains are oval to round, not irregular, and bell-shaped grains are present. The tiny spheres are oil droplets. Letters next to grains indicate the following: B, bell-shaped; Db, with a double border on the edge; Ov, oval in shape; B (2), two bell-shaped grains joined together as they were formed in the amyloplast; R, round in shape; o, oil droplet. Most of the oil droplets that occurred with the starch grains were not included in the figure. (b) Starch grains from Zea mays ssp. mexicana (Chalco teosinte). This race of teosinte has a greater proportion of grains that are more like those in maize, but differences are still apparent in morphology when compared with maize. Irr, irregular in shape. Most of the oil droplets that occurred with the starch grains were not included in the figure. (c) Starch grains from the maize race Reventador. As is typical of maize, many grains are irregular, and oval, round, and bell-shaped grains are absent or nearly so. In this race, many grains also have transverse fissures. Irr, irregular in shape; Tf, transverse fissure. (d) Starch grains from the maize race Bolita


Zea mays

Zea mays, Race Argentine popcorn

Starch

Starch grains from maize kernels, Race Argentine popcorn. 80x

Zea mays, raza Cateto cristalino

Zea mays, raza Caribe temprano (Early Caribbean)

Starch

Zea mays, raza Chandelle (Canilla en Cuba y Venezuela)

Zea mays, raza Negrito de Colombia

Starch

*Zea mays*, Race Pepetilla

Starch

Starch grains from maize kernels, Race Pepetilla. 160x

Zea mays, raza Pollo

Starch

Zea mays, raza Tusón (Tuşon)

Starch

Zea mays

Starch

Fig. 2. Range of variation in archaeological maize starch. A, D and G: Simple starch grains, five to six two-dimensional polygonal sides. B: Assemblage of simple starch grains. C: Same starch grains with polarized light. E: Irregular starch grain with deep compression facets. F: Same starch grain with polarized light. H: Assemblage of simple starch grains. I: Same starch grains with polarized light (Scale bars: 10 mm)

Starch

Fig. 4. Ancient (a-k) and modern (l-p, framed by a dashed line) maize starch grains. a-h, and k are secure identifications; i and j are tentative identifications due to surface damaging. a1-k1 are the same ancient maize starches labeled with unnumbered letters, but under polarized light and dark field. Provenances: starches a-b (artifact E-1); h (artifact E-3); c, e, f (artifact SJ-4); d, g, i, j and k (artifact SJ-5). Modern maize starch grains come from comparative indigenous landraces (Pagan-Jimenez reference collection): l, n-o (Pollo, Colombia); m (Cabuya, Colombia); p (Nal-Tel, Mexico, intentionally affected by heavy grinding experiments). m1-p1 are the same modern maize starches labeled with unnumbered letters, but under polarized light and dark field. Figure legend: “tf” ¼ transverse fissure; “Tf” ¼ fissure with a “T” shape; “as” ¼ asymmetric fissure; “yf” ¼ fissure with a “Y” shape; “rf-s” ¼ radial fissure/striation; “db” ¼ double-border; “br” ¼ bright ring.
Fig. 9. k, modern maize starch with pits made by enzymatic (amylase) digestion during fermentation with saliva (Pagan-Jimenez lab notes).
Zea mays

Phytolith

SILICA BODIES IN ABAXIAL LEAF EPIDERMIS
OF ZEA MAYS

MICROHAIR BASE

INTER-
COSTAL
ZONE

I.C

INTERSTOMATAL CELL (I.C.)

STOMA

LONG CELL

VEIN

SHORT CELL (SILICA)

SHORT CELL (CORK)

Fig. 1—Spodogram of Zea mays L. (after Metcalfe, 1960).

Zea mays

Phytolith

a. Variant 1 cross of Zea mays

Zea mays

Phytolith

FIGURES 13-16. 16, A Variant 1 (mirror-image) cross-shaped phytolith from Zea mays (x400).

Zea mays

Phytolith


Zea mays

Phytolith

Fig. 21. Top center and bottom, three cross-shaped phytoliths enclosed in the leaf epidermis of maize. The two Variant 1 cross-bodies at the bottom are wider than the Variant 6 cross body at the top. This difference in the size of different cross-body variants typifies maize and other grasses, and also contributes to accurate identification archaeologically.

Zea mays

Phytolith

Figure 3. Cob bodies from Real Alto samples. A, wavy top rondel; B, wide rectangular IRP. Photographs taken at 400 x.

Phytolith

Fig. 1. Zea rondel phytoliths, bottom and side views of each type. (a–c) Wavy-top rondel; (d–f) ruffle-top rondel; (g–i) half-decorated rondel. See text for diagnostic features.

Fig. 2. Potential ‘confuser’ rondels from G. angustifolia. (a) Side view of three-spiked rondel. Note the solid, darkened lines of the edge spikes indicating their solid nature; (b) rotation of a three-spiked rondel showing the solid upper surface with solid spikes; (c) solid-topped decorated rondel showing angular edges and solid surface of the top; (d) solid-topped decorated rondel in side view, showing the angularity of the top edge.

Fig. 2. Examples of wavy-top rondels, ruffle-top rondels, and half-decorated rondels, which were the subject of the study by Pearsall et al. [17].

a: ruffle top rondel, side view, ruffled top is to the right; b: ruffle-top rondels, rondel faces are up (sharp focus), ruffled faces are down; c: wavy-top rondel, wavy top is to the right; d: wavy-top rondel, wavy top is up; e, f: half-decorated rondels.
Zea mays

Phytolith

Fig. 6. Comparative maize cob phytoliths, a: wavy top rondel; b: ruffle top rondel; c: robust globular; d: half-decorated rondel; e: half-decorated oblong; f: wide IRP; g: irregular IRP.

Fig. 8. Archaeological maize cob phytoliths, a: wavy top rondel, side view, from 3294-A; b: wavy top rondel, top view, 3415-A; c: wavy top rondel, house floor sample; d: ruffle top rondel, 3294-B, e: ruffle top rondel, top view, 3415-B; f: wide IRP, 3331-B; g: wide IRP, house floor sample; h: half-decorated rondel, 3292-A; is half-decorated oblong, 3292-A.

Zea mays

Phytolith

wavy top rondel:
Rectangular bases, bilobate bases, and saddle bases are excluded from this type.
Occur only in maize.
Good maize indicator even within the range of teosinte.
Diagnostic level: species, domesticated

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays

Phytolith

Ruffle-top rondel
Zea mays

Phytolith

Ruffle-top rondel

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays

Phytolith

Diagnostic level: Zea spp. and some other panicoid grasses. Irregular IRP, IRP type was first described by Piperno and Pearsall (1993). IRP bodies are the product of epidermal silicification in the fruitcase, cupule, glume, and other infl. tissues. Found in Zea spp., Panicum bulbosum, and Lasiacis spp. (panicoid grasses), and Neurolepis pittieri (bamboo)

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays

Phytolith

wavy top rondel: Described by Bozarth (1993). Rectangular bases, bilobate bases, and saddle bases are excluded from this type. Occur only in maize. Good maize indicator even within the range of teosinte. Diagnostic level: species, domesticated

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays mays

Phytolith

wavy top rondel: Described by Bozarth (1993). Rectangular bases, bilobate bases, and saddle bases are excluded from this type. Occur only in maize. Good maize indicator even within the range of teosinte. Diagnostic level: species, domesticated

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays mays

Phytolith

Diagnostic level: species, domesticated
Gracile spherical body
This is a relatively rare type that occurs in maize, and not in teosinte or other wild panicoid grasses.
Compare to their robust cousins (Robust globular bodies) in size, nature of projections, and degree of silicification

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays, race “pepitillo”

Phytolith

Rectangular IRP, Wide (>7.5 microns width). IRP type was first described by Piperno and Pearsall (1993). IRP bodies are the product of epidermal silicification in the fruitcase, cupule, glume, and other infl. tissues. Diagnostic level: Zea spp. and some other panicoid grasses

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Zea mays

Phytolith

Fig. 8. Examples of wavy-top rondels from maize. The phytolith on the bottom right is a ruffle-top rondel from maize, for comparison. Reprinted from Piperno (2006a), Copyright AltaMira Press.
Zea mays

Fig. 2. Wavy-top (top, bottom left) and ruffle-top rondels (bottom, right) from maize. Ruffle-top rondels occur much more frequently in teosinte than maize. From Piperno, 2006

Fig. 3. The various kinds of non-rondel phytoliths found in teosinte fruitcases. Those diagnostic of teosinte are in the center (a, oblong, one-half decorated; b, elongated spiney; c, elongated with one wavy and one serrated edge). Phytoliths aef occur in some non-Zea grasses, but they like the others are always produced in teosinte and can be used to rule out its presence if absent from samples. The phytoliths range in size from about 10 (phytolith f) to 35 mM in diameter (phytolith b). From Piperno, 2006.

Figure 3. Maize diagnostic phytolith (narrow elongate rondel) for Andes: (a) narrow elongate rondel from modern reference maize; (b) two narrow elongate rondels in tissue from teeth of possible human sacrifice (Locus 5282) from Kala Uyuni; (c) and (d) narrow elongate rondels from manos (Loci 3132, 3110) from Chiripa Quispe.

Rondels from the cob of Zea mays L., race Maiz Ancho (400x). As the rondel phytoliths from maize, and especially bamboos tend to be thick when formed in plant, the rondel daces that are oriented toward the investigator in plant tissue become the lateral edges of the phytoliths after they are removed from the plant and mounted on slides.
Zea mays

Phytolith

A phytolith from the glumes of maize cobs from the Aguadulce shelter. 160x. The phytolith is 14 microns long.

**Zea mays**

Phytolith

Fig. 3. Phytoliths from San Andre´s. (a–c) Maize cob phytoliths. (a) A ruffle top rondel from 1,115 cm. (b) A wavy top rondel from 1,115 cm. (c) A ruffle top rondel from 1,140 cm.

Zea mays

Phytolith

Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. d) Z. mays cobwavy-top rondel (K-VIII M. 1.1, 0e10 cm). e) Z. mays cob half-decorated rondel (P Ridged Field 2, 0e10 cm).

Zea mays

Phytolith

Fig. 5. Selected microbotanical remains. Phytoliths: j) Z. mays cob wavy-top rondel, profile view (Sed. Sample 4), k) The same phytolith, rotated to top view, l) Z. mays cob IRP (Sed. Sample 3)

Zea mays

Phytolith

Fig. 10. Undecorated circular phytoliths from a cob of maize, Race Maiz Ancho from Mexico.

Zea mays ssp. parviglumis

Phytolith

Fig. 8. A fruitcase phytolith from Balsas teosinte. It is produced in the same tissue as phytolith illustrated from Tripsacum but lacks serrated edges and ridges along the top.

Fig. 9. A decorated circular phytolith from the fruitcase of Balsas teosinte.

Zea mays ssp. parviglumis

Phytolith

Fig. 5. Articulated phytoliths from a teosinte fruitcase. The lower image is a magnified view of the upper image. The “a” arrow points to the upper face of the rondel (sharp focus): this is the ruffle-top, which extends out beyond the base. The “b” arrow points to the lower face of the rondel, which is the rondel base. Photograph courtesy of I. Holst, Smithsonian Tropical Research Institute, Panama.
Zea mays ssp. parviglumis

Phytolith

Fig. 6. Phytoliths from the fruitcases of teosinte, Race Balsas (Zea mays ssp. parviglumis). Both the long and short cells (producing rondel phytoliths) are silicified. This process is under the control of the gene tga1. Reprinted from Piperno (2006a), Copyright AltaMira Press

Zea mays ssp. parviglumis var. parviglumis

Phytolith

FIGURES 69-72.-71, A teosinte-specific epidermal-cell phytolith from the fruitcase of Balsas teosinte (Zea mays ssp. parviglumis var. parviglumis) (x400)

Zea perennis

Phytolith

Body with semi-circular cuts. Teosinte indicator.
Diagnostic level: wild Zea spp.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
PTERIDACEAE
Fig. 6. Phytoliths from Pteridophytes. b) Elongated undulating body from Pityogramma calomelanos, c-d) Pitted bodies from P. calomelanos

RESTIONACEAE
Anthochortus ecklonii

Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. F. Anthochortus ecklonii (Restionaceae), spherical silica bodies overlying the sclerenchymatous bundle sheath (bar = 10µm).

Thamnochortus floribundus

Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. E. Thamnochortus floribundus (Restionaceae), an irregular or granular form of silica observed in epidermal cells (bar = 10μm).

SIMAROUBACEAE
Simarouba amara

Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. n) Trichome with V1 material from S. amara o) Vesicular infilling from Simarouba amara.

SMILACACEAE
Smilax dominguensis

Starch

SOLANACEAE
### Capsicum annum

#### Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>Flower</th>
<th>Non diagnostic phytoliths:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a) Irregular epidermal silica cells.</td>
</tr>
<tr>
<td></td>
<td>b) Sub-spherical calcium oxalate phytoliths.</td>
</tr>
</tbody>
</table>

**References:** Reported as not present in Piperno 1988:35 (no specific part mentioned).

<table>
<thead>
<tr>
<th>Stem</th>
<th>No phytoliths.</th>
</tr>
</thead>
</table>

**References:** Reported as not present in Piperno 1988:35 (no specific part mentioned).

#### Starch assemblage characterization

a) Mainly single grains, variable in shape, commonly oval, but also spherical, ellipsoidal, kidney-shaped, polyhedral and triangular, with rounded sides; variable in size from 10μm to 23μm long length; rarely distinct hilum as a dot; not visible lamella; centric cross, with four arms visible, intersecting at a point or line, or meeting two by two.

b) Some compound grains, oval, ca. 22μm, compounded by two granula, with a single external packing. Granula different in size, ranging from 12μm to 15μm, distinct cross with four arms visible, meeting two by two.

Scale bar = 20μm.

Korstanje and Babot, McCown Archaeobotany Laboratory Collection
Capsicum sp.

Starch

Fig. 5. Selected microbotanical remains. Starch grains: f) cf. Capsicum sp. (SAL 06-2-1671)

Capsicum sp.

Starch

Fig. 7. Chili pepper starch grains from St. John and Eva 2. a, lenticular starch showing a lightly rough surface; a1, the same starch with smooth extinction cross; b, lenticular starch with a big central depression (“cd”); b1, the same starch with bright extinction cross; c, lenticular starch with partially exposed lamellae (“L”). Provenances: starches a and b (artifact E-4); c (artifact SJ-4).

# Nicotiana tabacum

## Phytolith assemblage characterization

<table>
<thead>
<tr>
<th>leaf</th>
<th>No silica phytoliths.</th>
</tr>
</thead>
</table>

**References:** Mentioned but not reported in Bozarth 1987 and 1990.

## Starch assemblage characterization

<table>
<thead>
<tr>
<th>leaf</th>
<th>a) Single grains, oval, spherical, polyhedral, and bell-shaped grains, with wavy end; variable in size from 12 µm to 20 µm long length; not visible hilum and lamella; centric cross, with four arms visible.</th>
</tr>
</thead>
</table>

Scale bar = 20 µm.

---

Korstanje and Babot,
McCown Archaeobotany Laboratory Collection
Solanum torvum

Australian Museum, McCown Archaeobotany Laboratory Collection
Solanum tuberosum

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>No silica phytoliths.</td>
</tr>
</tbody>
</table>

References: Reported as not present for *Solanum nigrum* (no specific part mentioned) (Piperno 1988:35).

<table>
<thead>
<tr>
<th>Starch assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Single grains, oval, ellipsoidal, ovoid, spherical, sausage- and pear-shaped, with a narrow end generally rounded or truncated; variable in size, frequently over 100μm, to 120μm long length; distinct highly eccentric hilum, usually at rounded end, occasionally double, as a circle or line; very distinct lamella; distinct eccentric cross, to the broader end, with four arms visible, two long and two short.</td>
</tr>
</tbody>
</table>

Tuber

<table>
<thead>
<tr>
<th>Tuber, stem and leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale bar = 20μm.</td>
</tr>
</tbody>
</table>

b) Compound grains, compounded by two granula. Granula similar in shape and size, bell- and bowl-shaped, with one truncated, concave or convex end.

Solanum tuberosum

Figure 4. White potato non-processed starch grains. Views with normal (left) and polarised light (right). Scale bar = 20μm.

Solanum tuberosum

Starch

STERCULIAEACEAE
Guazuma ulmifolia

Phytolith


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Guazuma ulmifolia

Phytolith

PC 2870, wood specimen
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Guazuma ulmifolia

Phytolith

PC 2870, wood specimen
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Guazuma ulmifolia

Phytolith

PC 2870, wood specimen
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Watteria americana

Phytolith

PC Clark 33
Diagnostic: Watteria, Sterculiaceae

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Waltheria indica

Phytolith

4. Silicified tracheid from Waltheria indica (400 x ).

STRELITZIACEAE
Phenakospermum guianensis

Phytolith

Fig. 3. Phytoliths from non-grass monocots. p) Druse-like bodies from Phenakospermum guianensis

Phenakospermum guyannense

Phytolith


Ravenala madagascariensis

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. C. Ravenala madagascariensis (Strelitziaceae), spiny silica bodies in vascular bundle-sheath cells (bar = 10µm).

Ravenala madagascariensis

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). L, fringed D1 druse from Ravenala madagascariensis leaf. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Strelitzia augusta

Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. D. Strelitzia augusta (Strelitziaceae), a bundle-sheath cell containing a druse-like silica body (bar=20µm).

Strelitzia reginae

Phytolith


THELYPTERIDACEAE
Fig. 6. Phytoliths from Pteridophytes. a) Epidermal phytolith from Thelypteris confluens, f-g) Aspherical granulate bodies from T. confluens

THURNIACEAE
Thurnia jenmanii

Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. G. Thurnia jenmanii (Thurniaceae), numerous small spherical/nodular bodies in epidermal cells (bar = 10 µm).

**Tropeolum tuberosum**

<table>
<thead>
<tr>
<th>Phytolith assemblage characterization</th>
<th>Starch assemblage characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>tuber</strong></td>
<td>a) Single grains, globular or subglobular; less than 7μm.</td>
</tr>
<tr>
<td></td>
<td>b) Single grains, generally symmetrical, globular, subglobular, truncated, ovoid, spherical and bell-shaped; from 4μm to 28μm long length; very distinct lamella; distinct eccentric cross to the rounded end, with well defined dark arms intersecting at one point, two long and two short.</td>
</tr>
<tr>
<td></td>
<td>c) Compound grains compounded by two-three granula. Granula, generally unequal, with at least a symmetry axis.</td>
</tr>
<tr>
<td><strong>stem</strong></td>
<td>No diagnostic phytoliths (*).</td>
</tr>
<tr>
<td><strong>leaf</strong></td>
<td>No phytoliths (*).</td>
</tr>
</tbody>
</table>

**References:** Partially based on Cortella and Pochettino 1995.
ULMACEAE
Fig. 6. A family-specific phytolith from the fruit of Altis spinosa (Ulmaceae).

Celtis schippii

Phytolith

20 V a,b, and c separated only by arrangement of conical bodies. 20 V Ca describes when these conical bodies occur singly. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Celtis schippii

Phytolith

Occurs singly in Celtis schippii leaf and fruit. 20 V a,b, and c separated only by arrangement of conical bodies. 20 V Ca describes a singly occurring conical body. 20 V Cb describes when 2 of these bodies are fused along their flat surfaces. 20 V Cc describes when these conical

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Celtis schippii

Phytolith

20 V a,b, and c separated only by arrangement of conical bodies. 20 V Cc describes when these conical bodies occur in fused masses. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Celtis schippii

Phytolith

Seed or fruit epidermal cells. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Celtis schippii

Phytolith

See Record #61 for another view. 20 V a,b, and c separated only by arrangement of conical bodies. 20 V Ca describes when these conical bodies occur singly. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Celtis schippii

Phytolith

See Record #63 for another view. 20 V a,b, and c separated only by arrangement of conical bodies. 20 V Cc describes when these conical bodies occur in fused masses. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Celtis schippii

Phytolith

Occurs in fruit. Type defined by Cesar Veintimilla 05/1991. Diagnostic level: species

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trema integerrima

Phytolith

Type defined by Cesar Veintimilla
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trema integerrima

Phytolith

Type defined by Cesar Veintimilla 06/1991.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trema micrantha

Phytolith

Hair often has cystoliths inserted in base. Some examples have slight surface texturing, but most are smooth. Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trema micrantha

Phytolith

Hair. Note cystoliths inserted in the base.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trema micrantha

Phytolith

Hair base. Only some of the smaller cells are still with the hair base in this example.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trema micrantha

Phytolith

Type defined by Cesar Veintimilla
05/1991.
Diagnostic level: genus

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Trema micrantha

Phytolith

Slide 466 leaf.
Diagnostic level: generalized arboreal

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
URTICACEAE
Boehmeria aspera

Phytolith

1. Thin, curved hairs from Boehmeria aspera (200 x ). Also present is a partially armed hair.
4. Spherical nodular cystoliths from Boehmeria aspera. They are attached to polyhedral epidermis (200 x ).

Cecropia peltata

Phytolith

3. Hair base with short lines projecting from the perimeter from Cecropia peltata (200x)

Laportea aestuans

Phytolith

2. A non-segmented hair cell from Laportea aestuans (400 × ).

Laportea aestuans

Phytolith

2. An elongate cystolith with two blunt ends and dense surface nodulation from Laportea aestuans (400 X).
3. An elongate cystolith with an indented middle from Laportea aestuans (400 x).

Pilea acuminata

Phytolith

1. A curved, nodular cystolith from Pilea acuminata (250 X )

Pouzolzia obliqua

Phytolith

3. Non-segmented armed hairs from Pouzolzia obliqua. Also present are unarmed hairs, and in the middle a cystolith (156 × )

Urera elata

Phytolith

4. Cystoliths from Urera elata (156 x ).

ZAMIACEAE
Zamia sp.

Starch

Fig. 2. Selected archaeological starch grains. (F) Zamia sp. starch from Hornito, scraper E18, 7700 cal BP. Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.

Zamia sp.

Fig. 8. Marunguey starch grains from Eva 2. a, truncated starch diagnostic to the genus showing smooth lamellae and a single pressure facet (“pf”) at the distal end; a1, the same starch showing the particular extinction cross defined for the genus; b, oval starch with concentric rings or lamellae (“L”) lightly undulated; c, oval starch of cf. Zamia spp. showing undulated lamellae (“L”) and 5 smaller starches partially attached. Provenances: a (artifact E-1); b and c (artifact E-2).

Zamia amblyphyllidia

Starch

Zamia portoricensis

Starch

Zamia pumila

Starch

ZINGIBERACEAE
Zingiberaceae cf.

Starch

Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. f, cf. Zingiberaceae starch with multiple crackings and fissures on the surface, and remarkable lamellae.

Aframomum angustifolium

Phytolith


Alpinia blepharocalyx

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). T, globular-microrugulates (arrow) and silica sand from Alpinia blepharocalyx leaf. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. G. Alpinia conchigera Zingiberaceae), two forms of silica: intercostal silica sand and costal spherical bodies in epidermal cells (bar = 10 µm).

Alpinia galanga

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). S, globular-rugulate from Alpinia galanga fruit. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Amomum lepicarpum

Phytolith


Costus guanaienis

**Phytolith**

Diagnostic level: Potential species-level diagnostic, under study. Type overlaps with 801Ka, but is distinguished by larger size. Occurs in rhizome.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Costus guanaienis

Phytolith

Diagnostic level: Potential species-level diagnostic, under study. Type overlaps with 80IKa, but is distinguished by larger size.
Occurs in rhizome.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Costus guanaienis

Phytolith

Large nodular sphere, 18 microns and larger in size, with short projections with large basal diameter. Sphere can be slightly irregularly shaped.
Diagnostic level: Family

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Costus guanaienis

Phytolith

These spheres have nodular and spinulose projections or silia. Nodular projections outnumber spinulose or cilia. Projections are tightly spaced. Diagnostic level: Under investigation.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Costus scaber

Phytolith

Also occurs in the Bombacaceae. Diagnostic level: mixed, Zingiberaceae, Bombacaceae. There are subtle differences in the smoothness and abundance of nodules between the two families.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Costus scaber

Phytolith

PC2744, root
Type originally defined by Karol Chandler-Ezell.
Image shows top view; note the narrow rim.
Diagnostic level: under study

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Hornstedtia conica

Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. F. Hornstedtia conica (Zingiberaceae), epidermal, intercostal silica sand (bar = 10 µm).

Hornstedtia spathulata

Phytolith


Kaempferia aethiopia

Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. E. Kaempferia aethiopia (Zingiberaceae), an internal costal silica body (bar = 10µm).

Renealmia occidentalis

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). Y, globular-rugulose-granulates from Renealmia occidentalis fruit+seed. Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Renealmia oligosperma

Phytolith

Diagnositc level: under study. Also observed in Donax, Thalia (Marantaceae)

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.
Spirematospermum sp.

Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). BB, silica sand from Spirematospermum seed (Fasterholtz, Germany). Scale bars=A, C–S, U–AA=12 µm; B, T, BB=23 µm.

Zingiber officinale

Phytolith


Zingiber officinale

Australian Museum, McCown Archaeobotany Laboratory Collection
Zingiber officinale

Australian Museum,
McCown Archaeobotany
Laboratory Collection
Zingiberales

Phytolith

j. Irregularly angled rugulose chain fragment diagnostic of the order Zingiberales, and possibly derived from *Canna*.

Fig. 1. Stylized drawings of selected phytolith morphotypes. A, D1 and D2 druses, distinguished by visible spikes on D1 druses. B, hat-shapes, defined by a relatively flat and translucent base. C, T1 and T2 troughs, identified by height of central process. T1 troughs are generally flat while T2 rise rapidly. D, two textures of globulars, although they can exist in a larger range of textures. E, tabular-type phytoliths, with Ta1 example. F, knobby-type phytoliths, with Kn2 example. All reported measurements are made along the longest axis.

Fig. 5. A comparison of family-level morphotype production against phylogeny. There is no apparent correlation of morphotype to phylogenetic relationship. Phylogenetic tree based on Kress et al. (2001). Symbols are as in Fig. 1, except differences within tabular and druse morphotypes was not made as the subcategories often intergrade.